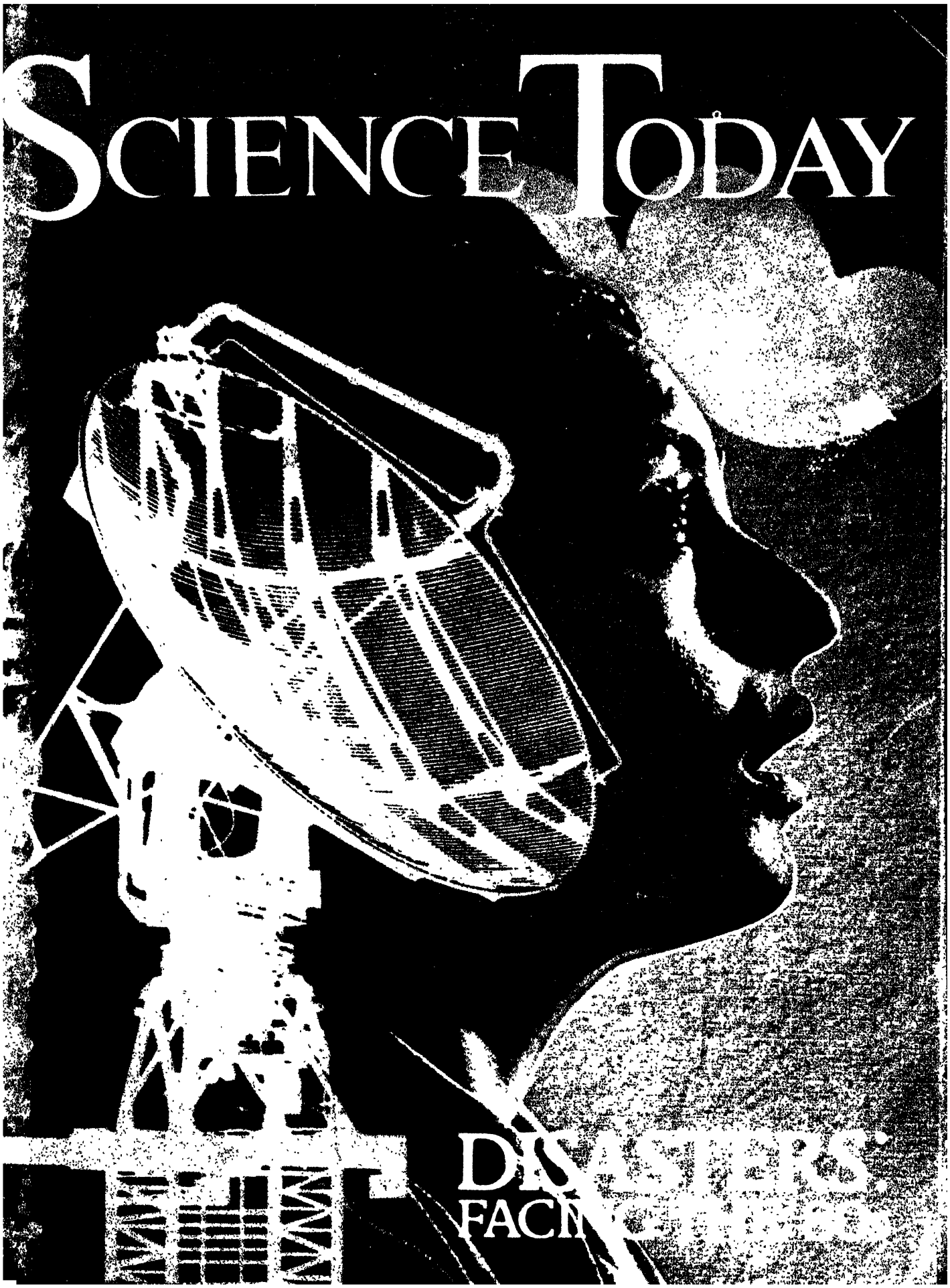
SCIENCE TODAY



DA
FACT

Here comes India's first ever 13-tonner...

Ashok TUSKER

to carry more load-to earn more profit



At 13 T it's now India's heaviest vehicle in the medium duty range with the permissible rear axle rating and with over 1 T extra load carrying capacity. The result? Extra income of well up to Rs. 20,000/- a year!

It s already quite a sensation· the latest from Ashok Leyland Ashok Tusker India s first ever 13 tonner

A result of Ashok Leyland s R & D it is designed on the higher payload concept—with the front axle strengthened by 1 T Yet it is well within the permissible limit of 8 T per axle

About Rs. 20,000 extra earnings for the extra tonnage!

Higher load carrying capacity naturally means higher profit And with Ashok Tusker it could easily mean an extra income of Rs 20 000 - a year

Larger loading span too:

Ashok Tusker has a 40 7 cm longer loading span Which means extra loading area that s specially helpful for carrying heavy bulk loads

The most powerful engine· 125 BHP

That s right It s an A! 400 engine 125 BHP at 2400 rpm—capable of delivering a torque of 41 5 kg m at 1600 rpm The result it has more haulage power, larger reserve power and naturally higher power to weight ratio

What s more the engine, built on Ashok Ley'and technology with groove insert piston and hardened liners lasts much longer consumes less engine oil

Tusker's strong points

A big strong clutch—35 7 cm in diameter designed to cope with the high torque output of the engine

More stopping power—to match the extra driving power the total stopping area being 3580 sq cm

Stronger bigger front axle beam, front axle bearings propeller shaft, and axle arms —all designed to take on the additional load

And of course, the 125 BHP engine!



Ashok Leyland

—the name that carries weight

Ashok Leyland Limited

Ennore Madras 600 057

THE SECRET OF MY SUCCESS
THE BRITISH INSTITUTES



"With great pleasure & pride I shall tell you that this training has helped me in getting a new more responsible & challenging assignment in an international pharmaceutical organisation as "Manager, Pharmaceuticals Production"

Says Manohar A. Potdar Student No [BM 228X who passed DBM (IMC Exam nat on n December 1979 w th F rst Cl s securing D st nct on n Pr duct on Management

and thousands of other successful students agree.
YOU CAN ACHIEVE CAREER SUCCESS TOO!

pecialised Training for

D B M (I M C) D COM (Bus Org) CERT A I I B D COM (Banking), D COM (Accounts & I Tax) D COM (Costing) D COM (Comp Sec) A C S (India) A I A M C A ENTRANCE, A M I E (India) A M I Mech E (INDIA) A M I I CHEM E A M Ae S I A S E (LONDON) N P SUPER VISORS and I I T ENTRANCE EXAMINATIONS

We a e recognised as an official training centre for Cert A I I B D Com (I M C) and D B M (I M C) examinations

Career Oriented Diploma Courses in

COMMERCE:

ACCOUNTANCY COST ACCOUNTANCY Banking Income Tax Practice Company Se retaryship Salesmanship PERSONAL SECRE TARYSHIP Shorthand (Pitman) GOOD ENGLISH College English BUSINESS LETTERS BUSINESS TRAINING German French Russian Fiction Writing ARTICLE WRITING Reporting Stage Radio & T V Wr ting Wr ting for Children COMMERCIAL ART Personality Develop ment

MANAGEMENT:

BUSINESS MANAGEMENT Sales Management MARKETING Mgt Advertising, INDUSTRIAL ADM Purchase Mgt Materials Mgt PERSONNEL MGT Office Mgt Management Accountancy, EXPORT MGT Junior Executive s MANAGEMENT EXECUTIVE S BUSINESS ADMINISTRATION

ENGINEERING:

MECHANICAL ENGG Mech Draughtsmanship CIVIL ENGG Overseer s (Bldgs & Roads) ARCHITECTURE Text l Technology TEXTILE MANUFACTURE Computer Programming IBM 360 AUTOCODER PROGRAMMING Industrial Engg AUTOMOBILE ENGG Diesel Engg ELECTRICAL ENGINEERING & ELECTRONICS Electrical Supervision RADIO ENGG TRANSISTOR ENGINEERING Television REFRIGERA TION Chemical Engineering PETROLEUM TECHNOLOGY Rubber Technology INDUSTRIAL CHEMISTRY

Tools and Kits supplied fo Radio Engg and Transistor Engg courses

Write today send coupon come personally or telephone 256755

THE BRITISH INSTITUTES
56/B16 P O Box 1025 359 D N Road Bombay 400 023

THE BRITISH INSTITUTES 56/B16 P O Box 1025 359 D N Road Bombay 400 023
Send me a FREE P ospectus
Name
Address



90 DAYS FROM NOW! speak any foreign language fluently

Suddenly a new and living language dawns on you Horizons broaden immeasurably Alien cultures draw closer with understanding And you with vital confidence become a social and business success Linguaphone is the most natural way to learn a foreign language and enables you to gain a natural conversational speech effortlessly 4 million people all over the world have already learnt a new language through

LINGUAPHONE

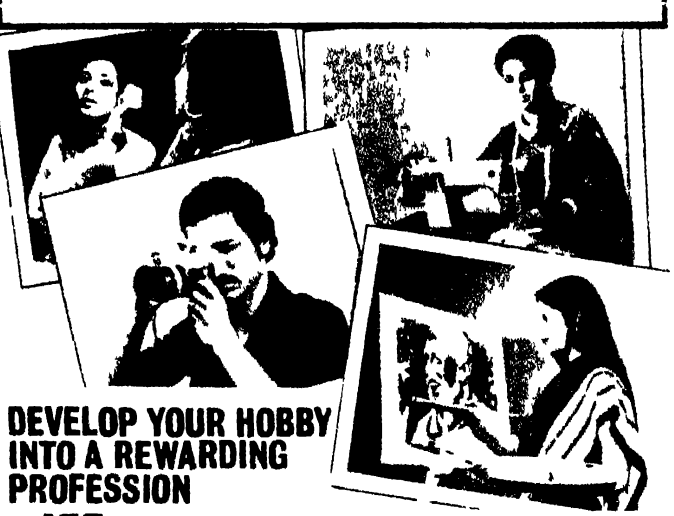
For full details of French German Polish Russian Japanese Spanish Persian Arabic Chinese (Mandarin) Chinese (Cantonese) Malay English Intermediate & Advanced English Hindi or any of the 38 languages write today send coupon or come personally to

LINGUAPHONE INSTITUTE (Dept 56/F16)
359 D Naoroji Road, Bombay 400 023
Demonstration Centres at
13 1A Govt Place East Calcutta 700 06
13 Daryaganj New Delhi 110 002
36 Mount Road Madras 600 002



Also available easy to carry travel packs in French German Spanish and Italian

LINGUAPHONE INSTITUTE 56/F16 359 D N Road Bombay 400 023
Please Send me a FREE Prospectus for (specify language)
Name
Address



DEVELOP YOUR HOBBY INTO A REWARDING PROFESSION

LET **ICS** THE PIONEERS IN POSTAL EDUCATION, NURSE YOUR TALENTS IN

Beauty Care & Personality Photography Dress Making & Portrait Painting Oil Painting Fine Art Commercial Art Cartooning Water Colour Painting, Interior Decoration Pattern Cutting & Design ng Etiquette & Entertaining Flower Arrangement Poultry Keeping Gardening Free Lance Journalism Short Story Writing T V Script Writing

Other interesting courses in

Business Management Hotel & Catering Mgt Accountancy Private Secretaryship Public Relations French German Radio & T V Electronics Textile Design ng

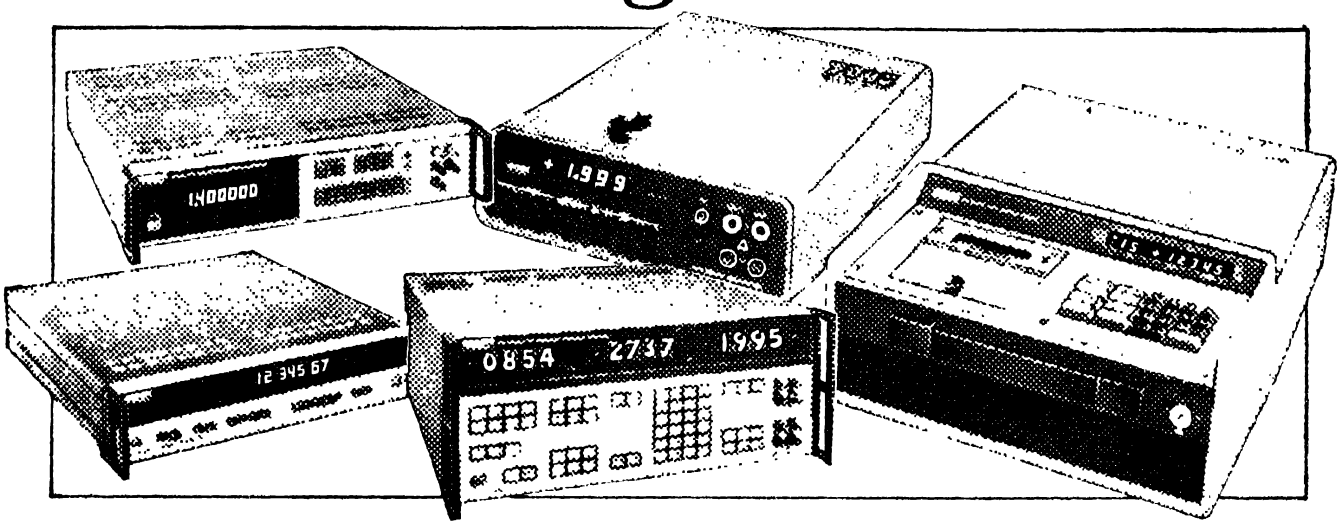
Write today send coupon come personally or telephone 256755

INTERNATIONAL CORRESPONDENCE SCHOOLS
56/D16 UCO Bank Bldg Hutatma Chowk P O Box 1931 Bombay 400 023

INTERNATIONAL CORRESPONDENCE SCHOOLS
56/D16 UCO Bank Bldg Hutatma Chowk P O Box 1931 Bombay 400 023
Please send me a FREE Prospectus for the SUBJECT
Name Educat
Address

NOT V CSL 11

Nelco proudly introduces the sophisticated, hi-precision range of Solartron Testing & Measuring Instruments



A valuable addition to your laboratory or institution, these instruments are manufactured by the world-renowned Solartron Electronic Group Ltd.—a Schlumberger Company.

These high-precision testing and measuring instruments will be available in India through valid import licences. After-sales servicing will be provided by Nelco's service personnel who have been specially trained by Solartron in India and U.K.

Some of their more notable instruments:

The 7045 Digital Voltmeter: This latest model outperforms competitors on every score. It offers 6 functions and 30 ranges. 1 μV DC voltage measurement, 1 nA—2A DC current measurement, AC volts and current and resistance. As well as a host of other advanced features.

The 7055 & 7065 Digital Voltmeters: These are excellent voltmeters that measure DC and AC volts as well as resistance They have 1μV sensitivity; auto and manual ranging; 3 x 9s to 6 x 9s scale lengths and 330 readings/s at 3 x 9s. But more they are processing voltmeters with 9 programs.

The 7075 Maestro Digital Voltmeter: It has broken new records in design and performance. It is a voltmeter with 14 million scale, < 2.5 ppm uncertainty, 1nV operating sensitivity, 200 readings per second, greater flexibility—5 integration times, 5 scale lengths and 5 measurement rates.

The 3430 Compact Logger: It is a truly portable instrument. It offers mains independence microprocessor control, linearisation, simple interactive keyboard, numeric display, 30 analogue inputs and tape cassette or strip printer recorder.

The 1172 Frequency Response Analyser: It is primarily used where investigation of Dynamic performance is required. The instrument features include, frequency range of 0.1 mHz—10 KHz. Superb resolution of gain and phase, wide dynamic range, true point to point measurement, fully floating input and output, bias add and reject and a comprehensive range of peripherals.

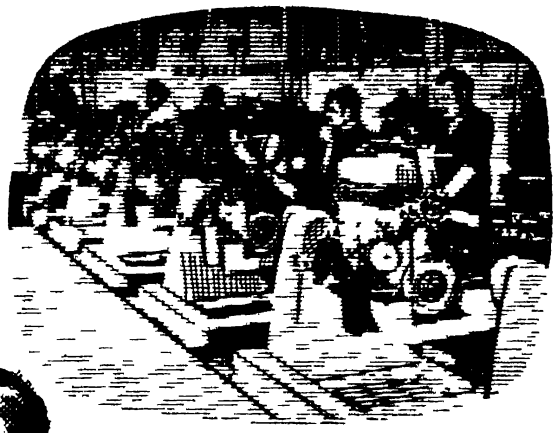
Write in for detailed information to:

NELCO

THE NATIONAL RADIO & ELECTRONICS CO.LTD.

Mahakali Road, Chakala, Andheri (East), Bombay 400 093.
Phone: 575621. Telex: NELF 11-4056. Grams: NELCO ANDHERI.







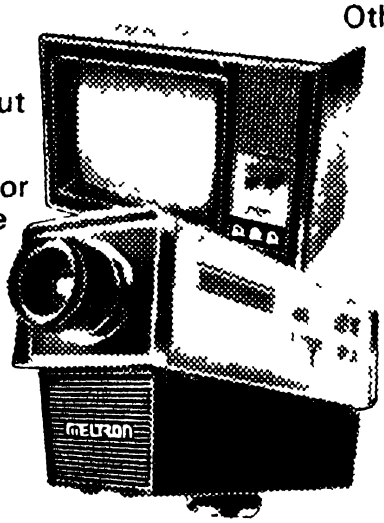
CHAITRA-ME-95 REV

The ever-watchful eye of
MELTRON CLOSED CIRCUIT TV

It's trained to improve productivity, profitability and protection.

- Monitors any remote place of your choice.
- Provides brilliant pictures without distortion.
- Built-in automatic light control for better reproduction in a wide range of light conditions.
- Variety of lenses including wide angle, telephoto and zoom.
- Compact, light-weight, portable.

Especially useful in educational institutions, hospitals, medical institutions, industries, department stores, banks, traffic control, railways, airlines, hotels, sports and public functions.



Other high-quality systems from MELTRON include:

1. Uninterrupted Power Supply Systems
2. Fire Alarm Systems
3. Digital Display Systems

I would like more information. Please send me your detailed folder on

- ☐ Meltron CCTV
- ☐ Meltron UPS System
- ☐ Meltron Fire Alarm System
- ☐ Meltron Digital Display System

(Please tick to indicate your requirement)

Name _____

Company address _____

_____

MELTRON Meeting the challenge of tomorrow.

Manufactured by: **Vishal Electronics Private Limited**

Marketed by: **Maharashtra Electronics Corporation Limited**

Plot No 214, Backbay Reclamation, Raheja Centre, 13th Floor, Nariman Point, Bombay 400 021.
Tel: 240538 Telex: 011-6817 ME Cable: MELTRON
7A, Hansalaya, 15, Barakhamba Road, New Delhi 110 001. Tel: 40641 Telex: 031-2815 MELN
55, Rama Nivas, 10th Cross, West of Chord Road, II Stage, Bangalore 560 010. Tel: 80772

IT SEALS, PROTECTS, BINDS, INSULATES, INCAPSULATES, REPAIRS...

...BUT AN INNOVATIVE MIND CAN FIND A LOT OF MORE WAYS TO USE IT.



Epocil®

G.P F.C. EPOXISED COMPOUND

Epocil is an Epoxy based compound, indigenously formulated to meet various materials requirements in Engineering Industrial Agricultural and Domestic fields. Materials management today does not mean only buying new products but also involves maintenance. Epocil is the wonder compound that no materials manager can do without. It seals oil leakages or air gaps insulates cable joints protects surfaces from adverse weather conditions repairs broken wares or machinery, incapsulates portions of wire or just binds two things together.
Because of its high adhesive quality Epocil can be used on any surface. And as it is in the form of putty it can be moulded in any shape. Its curing time is only 30 40 minutes. After it has hardened it remains totally unaffected by adverse weather chemically aggressive atmosphere temperature variations and can withstand the most rigorous operating conditions. It is available in packs of 1000 gms 250 gms and 125 gms.

EPOCIL-MORE THAN A HUNDRED & ONE WAYS TO USE IT.

Manufactured by :

DE DENSONS ENGINEERS

(A Unit of Yamuna Gases Ltd.)

Aggarwal House, 4/14A, Asaf Ali Road, New Delhi-110 002.

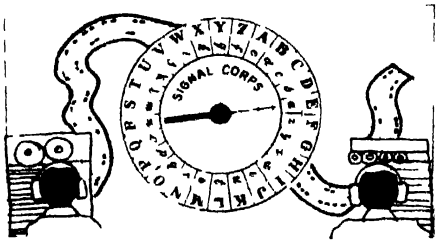
Phones : 278593, 278546

Science Today

July 1980 Vol 14 No 7

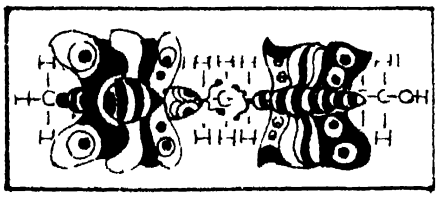
16 Communicating with codes
S Naranan

A recent revolution in cryptology makes it easy to devise safe codes



30 Olfactory invitation cards
K N Saxena

Insects can be tricked and trapped by using their own chemical messengers against them



39 Science and technology plan —pitfalls and promises

What should the science and technology programme in the Sixth Plan seek to achieve?

49 The method of science—7

How new discoveries in science disprove existing scientific beliefs

53 Disasters: facing the eighties
M S Swaminathan

An ounce of precaution is worth more than a tonne of post disaster aid

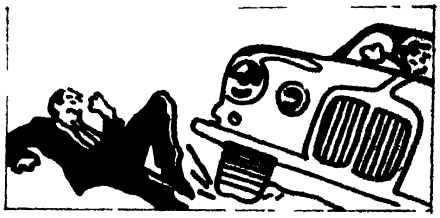
54 Quakes, floods and cyclones
P K Das

Coming disasters cast their shadows before the trick is to learn to recognise them well in advance



64 Murder? Suicide? Accident?
Pritam P Phatnani

Questions that need to be answered before investigating an unnatural death



2 Letters	29 ... and of scientists	63 If
9 Viewpoints	37 Ideas and Inventions	66 Fun with Mathematics
3 Science Shapes Life	46 Another Window	67 You Too Can Do It
27 Round-up of Research	51 Tell Us	68 Brain Teasers
29 This World of Science!	61 Books	68 Awards and Appointments

9 Is our press blind to science?

63 If there were no cosmic rays.

46 A rural experiment in relating science to everyday life

66 Cross-jump numbers

51 Why is the night sky dark?

67 IC-regulated DC supply



Cover Design Nana Shivalkar
Cover Photo Jayant Patel

Editor
Surendr Jha

Single copy Rs 2
Subscription 1 year Rs 20
2 years Rs 39 3 years Rs 58

Editorial queries are to be addressed to the Editor SCIENCE TODAY Times of India Building, Dr D N Road Bombay 400001 Unsolicited articles must carry adequate return postage

Subscription queries and payments should be addressed to the Circulation Manager SCIENCE TODAY Times of India Building, Dr D N Road Bombay 400001

Printed and published for the proprietors Bennett Coleman & Co Ltd by T P Pithavala at Usha Offset Printers Pvt Ltd 125 Govt Industrial Estate Kandivli Bombay 400 067 General Manager Dr Ram S Tarneja Branches 7 Bahadurshah Zafar Marg New Delhi 110 002 139 Ashram Road Ahmedabad 380 009 105/7A, S N Banerjee Road Calcutta 700 014 Offices at 13/1 Government Place East Calcutta 700 069 63 Montieth Road Egmore Madras 600 008 407 1 Tirath Bhavan Quarter-gate Pune 411 002 26 Station Approach Sudbury Wembley Middlesex London U K London Tel 01 903 9696

ROW MAN GROW!

AND LADIES TOO!

Are you fed up with being called Shorty', 'Little Man' or even Hey you down there'?

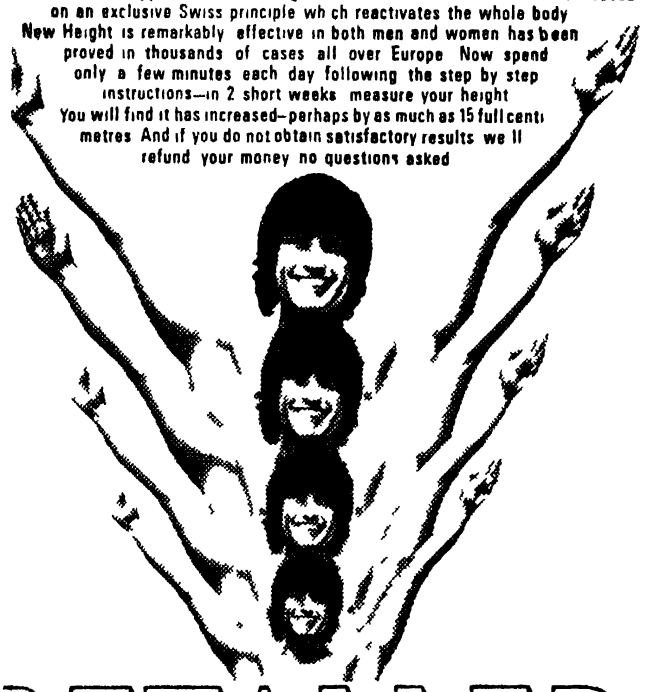
for the first time in Asia a complete step by step illustrated method that shows you how to add centimetres to your height

Grow as much as 5 to 15 cms in just 2 short weeks or pay nothing!

anting the NEW HEIGHT method for growing taller—whether you re young or men or woman No gadgets or strenuous exercises no artificial aids like ator shoes no appliances New Height is an all new scientific method based on an exclusive Swiss principle wh ch reactivates the whole body

New Height is remarkably effective in both men and women has been proved in thousands of cases all over Europe Now spend only a few minutes each day following the step by step instructions—in 2 short weeks measure your height

You will find it has increased—perhaps by as much as 15 full centi metres And if you do not obtain satisfactory results we ll refund your money no questions asked



BETALLER

TORRENT OF TRIBUTES OM NEW HEIGHT USERS

didn t think i was sible to gain height But my delight New Height ped me to reap gains til I reached 185 cms'
R K

The New Height course worth its weight in gold d more! My life has anged since I gained cms in height
H

SEND THIS COUPON TODAY

Whether it be social success love sports jobs or pleasure. the tall man always seems to get there first So act NOW for a new you Tall up rapidly and permanently Be Taller NOW!

Please note that the NEW HEIGHT COURSE is a BOOK OF INSTRUCTIONS on how to be taller and how to correct the posture with the help of certain scientific excercises IT IS NOT A MEDICINE OR DRUG

MAIL ORDER SALES PVT LTD (order dept N 115 Mathew Road Bombay 400 004

Yes I want to be taller Rush NEW HEIGHT for 10 day free home trial If not fully satisfied I may return everything for immediate refund (less postage a d forwarding charges)

Please tick appropriate box

ST 12

☐ Send by Registered Post Parcel I am sending Rs 18 (plus Rs 6 p & f) by Cheque/Draft/ I P O /M O No dt

☐ Send by V P P I promise to pay postma Rs 44 on delivery

Name

Address

Signature

Don't let a cold ruin your day.



A cold can be relieved

There is a way to relieve a runny nose or blocked nose heavy head sore throat and chest congestion—all those symptoms that can spoil the best of days

Fight it with a colds remedy

It s not enough to treat it like you would treat any other ailment Use a special colds medicine that works simultaneously on all affected areas

Coldarin is only for colds

Coldarin relieves all the symptoms that bring you down It has special ingredients that act together against all cold affected areas Plus Vitamin C to build your resistance When you have a cold it makes sense to treat it like a cold



COLDARIN

Specially formulated for colds

CASBC 64 242

MEDICAL ENTRANCE



Sunil Kumar Bansal
1st in Medical Entrance Delhi '77



Raghavendra Goswami
1st in Medical Entrance Wardha '77



Bhupinder Bhandari
1st in Medical Entrance Delhi '78



Rajiv Verma
2nd in Medical Entrance Delhi '78

THESE TOPPERS WERE OUR STUDENTS

And to crown it, while in 1977 out of the 35 students selected by the prestigious ALL INDIA INSTITUTE OF MEDICAL SCIENCES, as many as 16 were our students, in 1978 out of the 25 students selected by the same A.I.I.M.S., as many as 11 happen to be our students.

NEED WE SAY ANYTHING MORE ABOUT OUR RESULTS?

You too, have an opportunity to secure a position in these tests.

RESULTS OF I. I. T. ENTRANCE EQUALLY BRILLIANT

ENSURE YOUR SUCCESS THROUGH OUR COMPREHENSIVE

CORRESPONDENCE COURSE

ALSO PERSONAL TUITION CLASSES FOR I.I.T. AND MEDICAL ENTRANCE

HOSTEL FACILITIES EXIST

SACHDEVA NEW P. T. COLLEGE

29-T PATEL NAGAR, NEW DELHI-110008

32 T NEHRU PLACE, NEW DELHI-110019

Index to Science Today Volume 14 January–December 1980

Figures in italics denote issue numbers
January *1* February *2* There was no issue in October

Abiogenesis *6* 47
Acid rain *1* 16 *9* 41
Aegyptopithecus *4* 15
Aerobatics *9* 59
Aflatoxin *9* 13
Agrawal P C *8* 27
Aggarwal Yogi *4* 28
AIIMS *3* 7
Aiyar A S *4* 24
Alcohol and the brain *10* 14 from cassava *1* 28
Alcoholism genetic factor *7* 15
Aldehyde synthesis *3* 41
Allergies *4* 15
Altruism *3* 27
Alumina fibre composite *10* 49
Antibiotics and ancient Africans *11* 15
Antibodies mouse *9* 13
Antigens *5* 51
Ant repellent dye *7* 14
Apparao K M V *4* 23 *8* 31
Apte P M *1* 30
Arabs and science *10* 14
Archaeological dating ESR *5* 33
Arnold Arthur P *6* 59
Arora B L *4* 77
Astronomy infrared *9* 6
Atmosphere and life *6* 18 modelling *7* 59
Atmospheric circulation and day length *8* 34
Atomic energy *see* Nuclear energy
Automobiles aerodynamics of *8* 48
Awards & Appointments
Aryabhata medal *11* 65 Atomic Energy Agency Director *8* 71 Atomic Energy Commission Governing body *9* 67 Bhatnagar prize *2* 75 Coal Scientist award *11* 65 Committee on Science & Technology in Developing countries Chairman *6* 51 CSIR members *9* 67 Central Water Commission Chairman *5* 71 Dept of Atomic Energy Space Electronics and S & T Parliamentary Consultative Committee *9* 67 Dept of Space members *9* 67 Federation of Indian Chambers of Commerce & Industry awards *5* 57 ICSSR Chairman *8* 71 ICMR awards *2* 75 INSA awards *3* 71 President *11* 65 Silver Jubilee Medal *11* 65 Independence day awards for meritorious inventions 1980 *11* 65 International Council for Reprography Vice President *9* 67 Jawaharlal Nehru awards *5* 57 Kalinga prize *6* 51 Lady Tata Memorial awards *7* 68 Marconi award *3* 71 National Environment Fellowship *5* 71 Planning Commission Dy Chairman *6* 51 Space Sciences Advisory Committee *8* 71 VASVIK awards *11* 65 Vishwakarma medal *11* 65
B12 intestinal synthesis *4* 23
Bachhawat B K *2* 25
Bacteria ancient *8* 17 mammalian protein from *8* 31 square shaped *2* 16
Balaram S *6* 43
Bandyopadhyay J *10* 69
Banerjea H N *1* 11
Banerjee B *8* 55
Banerjee S *11* 33
Banerji D *2* 40
Banerji S N *9* 26
Bappu, M K V *2* 34
Barium cloud *5* 21
Basic research, universities *7* 45
Bats, echolocation *10* 36
Behaviour and genes *7* 7 evolution of *3* 23, 28, *6* 4
Bhanu B V *6* 24
Bhartendu Prakash *11* 47
Bhatia, C R *8* 47
Bhatnagar Arvind *2* 43
Bhattacharyya J C *5* 34
Bhattacharyya, P *11* 33
Bhattacharyya P C *3* 41
Bicycles chain wheels for *8* 61
Bindal V N *2* 55
Bioluminescence mechanism *11* 36 polarisation *11* 34 pesticide and *6* 13
Bipedalism human *9* 25
Birlasekaran S *8* 61
Big bang theory *1* 25 *3* 37
Birds nests *5* 64 Quiz *11* 55 Suicides *11* 13
Blindness colour *3* 19 *8* 58
Blood clots *6* 11 groups *5* 58
Books reviewed
Applied Chemistry a textbook of *7* 61 Biochemistry vol 1 2 & 3 *7* 57 Blueprint reading for mechanical traders *3* 71 Classical Mechanics introduction to *2* 57 COBOL and FORTRAN programming *5* 49 Computers genesis programming and applications *5* 49 Development scientific cooperation for *10* 59 Electronics industrial *9* 43 Fruit Physiology and production *6* 35 The mighty little atom *8* 55 Occupational health and safety in textile mill *2* 57 Operational amplifiers *9* 43 Plant physiology textbook of *3* 71 Plasma mechanics principles of *4* 53 Practical examinations for universities monographs on *6* 35 Radioimmunoassay and related techniques *7* 61 Tectonic geology of the Himalayas *1* 39 Television engineering *1* 53
Borkar Anil V *9* 43 *see also* You too can do it
Brain drain *4* 8 *8* 7 *9* 48
Brain cerebellum *1* 25 sexual differences *6* 53
Brainteasers *1* 43 *2* 63 *3* 41 *4* 17 *5* 49 *6* 67 *7* 68 *8* 71 *9* 59 *10* 69 *11* 43
Breast feeding and immunity *5* 21
Brown Lester *5* 47
Bubbles in the universe *1* 13
Burns Conference on *11* 9
Bustees *4* 42
Butterfly farming *7* 15

Calmodulin *9* 56
Cancer and hepatitis *10* 15 brain *11* 14 drugs from plants *5* 21 *8* 9 cells *9* 13
Cassava alcohol from *1* 28
Cell membrane *10* 19 tumour formation *4* 24
Cellulose pyrolysis of *6* 43
Cement policy *1* 8 *6* 4 technology *1* 9
Ceramic cracks *11* 33
Cereal tissue culture *11* 35
Chandra Feroze *5* 44 *6* 55
Chandra Mithesh *2* 55
Chandrashekaran M K *10* 40
Charm particles *3* 48
Chauhan P S *5* 35
Chhapgar B F *1* 35
China S & T policy *6* 29
Chitre S M *2* 40 *3* 57
Cigarettes side effects *10* 13
Claude George *9* 17
Climatic variations *6* 35
Clones *6* 47
Cloth insulation values of *8* 19
Coal de ashing of *1* 7 hydrogen from *4* 51
Colour blindness *3* 19 TV *10* 10
Comets parentage *10* 26
Common cold and cheerfulness *4* 14
Communication codes *7* 16 computer networks *3* 67
Computer errors and war *8* 19 networks *3* 67
Condor Californian *9* 14
Continental drift *6* 25
Contraceptives male *2* 15
Cooking vessels plastic *5* 21
Cosmic microwave background *1* 25 rays *7* 63
Crowding and puberty *10* 13
Cryptology *7* 16
Cussedness law of natural *2* 13
Cyclones *2* 7 tropical *7* 56

Da Costa Joao F *9* 33
DAE *5* 17
Daftary D K *10* 27
Damodaran V K *1* 53
D'Arsonval Arsene *9* 17 18
Das M R *10* 16
Davis Basil *3* 55
DDT in the environment *9* 26 in Indians *4* 13
Densitometer for films *5* 43
Dermatoglyphics *6* 15 22
Deshpande J M *5* 34
De Souza E I *5* 59
Dhar Deepak *5* 47
Diabetes *5* 57 58
Diatom *6* 46
Digestion in animals *2* 67
Dinosaurs extinction by asteroid *2* 17
Disasters natural 53 54
Display systems *4* 61
DNA helical structure *3* 5
Doctoral programme *9* 5
Dog fight aerobatics *9* 62
Dolphins *1* 32 *4* 7
Down syndrome maternal contribution 19 *4* 12
Durgapur EIN *11* 4
Dyes for printing ink 14

Earthing water pipes as 6
Earthquakes in 53 ring
Eclipse experiments *5* 17 families *80* guide *2* 43 mythology 35
Education medical *5* 10 post graduate engineering *9* 45 universities in Science *3* 9
Einstein X ray Laboratory *5* 1
Electrical earthing *5* 62 switchings surge comparison tester *1* 51
Electrides *4* 14
Electronics policy *4* 11
Energy alcohol *1* 28 atomic hazards *5* 1 by photolysis of water *11* 36 coal *1* 7 *4* 51 ocean thermal *1* 16 *9* 17 photosynthesis *1* 26 *9* 25 from waste *5* 15
Environmics bettering human performance *8* 60 chair design *1* 59 display systems *4* 61 fatigue and productivity *7* 69 thermal stress effect on workers *5* 66 *9* 5

Factorising large numbers *7* 21
Fermat theorem *5* 67
Fermions *5* 49
Fetoproteins alpha and gamma *5* 56
Fishing indiscriminate *5* 63
Fish thirst mechanism in *1* 6
Flatworm control of mosquito *5* 37
Flu virus *4* 15
Fonseca C *5* 65
Food and fuel relationship *5* 41 46 preservation hazards *3* 35
Foot and mouth disease *9* 5 vaccine *4* 15
Forces of nature *10* 30 unification theory *1* 19 *3* 43
Forensic medicine how doctors establish cause of death *5* 68 *7* 64 identity of the victim *1* 63 identity of the criminal *6* 66 motive *4* 68 place of crime *3* 52 time factor *2* 58
Fuel cells *7* 28 farms economics of *6* 41 level indicator *9* 65
Furnace husk fired *11* 48

Gadgil, Madhav *3* 28
Gamma: ray shower *4* 23
Gastroenteritis immunity *5* 21
Gauge theories *3* 47
Gears, toothless *1* 16
Genes: and behaviour *7* 7; and heredity *8* 57; selfish *3* 24; Recombination *10* 25
Genetic: code *1* 27; control of behaviour *3* 33; engineering *10* 13, 16, 22; therapy *11* 15
Geomagnetic field *7* 27; *8* 18
Geometry, teaching *9* 63
G-load *9* 60
Glycoproteins *2* 19
Godbole, R. D. *6* 35
Godbole, Rohini M. *5* 47
Godmen and miracles *7* 48
Gopalan, A. K. S. *5* 43
Gowariker, V. R. *8* 16
Gravitational lens *5* 7; *8* 31
Gravity absence of *1* 45
Gupta, H. D. *4* 63
Gupta, P. C. *4* 67
Gupta, Shashi K. *8* 39
Gupta, S. K. *4* 21
Gupta, Virendra *10* 35
Gupta, Y. P. *11* 11

Haber, R. N. *10* 58
Hallucinogenic plants *2* 15
Health, policy *2* 8
Heart disease, effect of hard and soft water *6* 12
Heat exchangers *9* 18
Helium probe *4* 17
Hemophilia *3* 65; *8* 57, 58
Hildebrand, J. H. *7* 11, *8* 40
Hookworm drug *10* 15
Hormone tests *6* 13, *11* 9
Houdini *9* 68
Housing, in Bombay *4* 30, Calcutta bustee improvement *4* 42, Kerala *4* 48, low cost *4* 26, 34; policy *4* 29, 31, problems, solutions *7* 7; roof structures *4* 36, rural *4* 38, slums *4* 40; statistics *4* 32; for the urban poor *4* 28
Hybridomas *9* 13
Hydrogen: from coal *4* 51, liquid, as fuel *2* 56

Ice, sticking with *10* 14
Idukki power project *8* 9
Immune system *5* 50
Immunoglobulins *5* 52, 59
Impotence *4* 14
India-Asia collision *6* 25
Inheritance *9* 15
In lighter moments *see* Scientists
Insect pheromones *7* 35
Insulin and slimming *3* 19
Interferon: interactions *2* 27; from plants *4* 13, laboratory trials *7* 14
Iyer, Raju *4* 53

Jagani, N. A. *2* 63
Jain, S. K. *8* 71
Jalnawalla, B. B. *10* 45
Jatras: Surya *5* 39; Vidnyan *7* 46
Jayaraman, K. S. *1* 12, *2* 11; *3* 15; *4* 11; *5* 17
Jayashree, S. *4* 63; *10* 61
Jha, Saroj S. *4* 67; *5* 59
Joglekar, P. J. *3* 63; *4* 53; *9* 43
Joshi, G. V. *6* 67
Jupiter, organic hues of *1* 17

Kale, V. S. *8* 67
Kamat, R. V. *2* 57; *8* 71
Kannan, K. K. *3* 37
Kaprekar, D. R. *1* 40, *4* 63
Kaul, Samvit *9* 25
Kembhavi, Ajit *1* 25
Kendrew, John (interview) *10* 22
Kepler, J. *7* 51
Kerala: housing technology *4* 48; People's Science Movement *1* 49
Ketones, synthesis of *3* 41
Knapsack problem *7* 24, 25
Kulkarni, S. J. *9* 37
Kumar, Sushil *10* 25
Kumar, Vasanth M. *9* 26

Lavakare, P. J. *9* 35
Letter-weighing device *6* 43
Leukotriene *4* 14
Life: and atmosphere *8* 18; origins of *8* 17; patenting of *8* 18
Likhite, S. D. *6* 26
Luna Conference *9* 30
Limaye, B. V. *8* 67
Lipids *2* 19
Lizards, pseudo-mating *2* 17
Lobo, U. *8* 65

Magnetic water treatment *10* 13
Magnetism of the earth *2* 63; in man *7* 15; *11* 13
Mahajan, B. S. *2* 67
Mahajan, S. K. *8* 33; *10* 24
Maheshwari, Nirmala *9* 57
Maheshwari, S. C. *3* 13
Malaria *11* 25
Malathi, K. N. *1* 41; *5* 65
Malhotra, Kusum *9* 57
Malshe, V. C. *4* 51; *6* 45
Man-ape ancestor *4* 15
Mani, M. S. *11* 42
Manohar, V. N. *4* 51
Mathematics, Bombay mathematics olympiad '79 *1* 55, *2* 65, *3* 74; codes *7* 16, coloured cubes problem *1* 41, cross jump numbers *7* 66, cryptology *7* 26, Fermat's theorem *8* 67; Law of first digits *3* 55; linear programming *2* 28, magic square *1* 40, magic tables *10* 61, magic star for 1980 *4* 63, polyominoes *5* 63; prime numbers *4* 63, *8* 67, products of squares *4* 63; *see also* Brain teasers
Matter-antimatter *11* 51; constituents of *10* 29
Mazumdar, B. K. *1* 43
Mehrotra, N. N. *4* 59
Membrane systems *10* 49
Menon, M. G. K. *9* 35
Meteorites *11* 34
Method of Science, discoveries and beliefs *7* 49, enquiry *6* 62, experiment *3* 64, historical landmarks *5* 60, introduction to the *1* 47, question and hypothesis *2* 61, observations and predictions *10* 71, the supernatural *9* 68, theory verification *8* 72, using the *4* 72
Microbiology quiz *6* 45
Milk production in India *2* 11
Miracles, explanations *7* 48
Misra Raj, D. N. *3* 71
Mistry, J. B. *2* 49
Mitra, A. P. *2* 51
Mitra, R. *8* 47
Mohan, Dinesh *4* 40
Mohanti, Dhirendra *6* 26
Monsters *5* 19
Monteiro, Anjali *7* 48
Monteiro, Vivek *5* 40
Moon, dust on earth *6* 11; if there was no *9* 55
Mosquito: Anopheles *11* 26 Juvenile hormone and biting *11* 14,) flatworm control of *3* 37
Mukherjee, D. P. *6* 21
Mukherji, K. C. *9* 47
Multiple choice tests *8* 59
Multiple sclerosis, cause *10* 25
Munshi, S. N. *9* 27; *10* 28
Murder *see* Forensic medicine
Murphy's law *2* 13
Muscle stimulator, solid state *8* 61
Muscular dystrophy *7* 15

Nadgir, B. B. *1* 39
Nair, K. G. *8* 11
Nanavati, A. N. D. *9* 54
Nanchne, D.M. *11* 43
Nanjundiah, V. *3* 33
Naranan, S. *7* 26
Narlikar, J. V. *1* 45; *5* 33
National Institute of Oceanography *9* 22
Nature, scientists' view of *4* 25
Nayudamma, report *9* 45
Neelakantan, K. K. *5* 65; *11* 57
Neptune: *1* 15, and Galileo *11* 14
Neutrinos: *3* 43, *11* 35; oscillating *6* 25
Neutron stars *8* 23
Nevatia, Jyoti *2* 47; *7* 28; *10* 26
Nobel prizes: *1* 13; 1980 *11* 39
Norohna, J. M. *4* 24
Nuclear: energy, policy *9* 10; force *3* 45; hazards *5* 17; lifetimes *2* 27; medicine, radiation protection *6* 37
Nucleon-nucleon interaction *5* 31
Numbers: factorisation *7* 21; large *7* 26

Obesity: *4* 71; insulin and slimming *3* 19
Ocean thermal energy *1* 16; *9* 17
Olbers paradox *7* 51
Oncogenesis *4* 24
Orchids: ghost *5* 21; from seeds *9* 4
Oscillations *see* vibrations
Ozone, depletion of *4* 57

Pain, control of *10* 13
Pandya, Sunil K. *10* 24
Paramasivam, S. *3* 71
Paranjape, P. V. *7* 28; *10* 49
Parthenogenesis *1* 15
Patil, Vijay N. *9* 67
Pedoe, Dan *9* 64
Pennathur, Krish *1* 59; *2* 69; *3* 60; *4* 61; *5* 66
People's Science Movements: Kerala *1* 49; surya jatra *5* 36; vidnyan jatra *7* 46
Perception of depth in pictures *10* 51
Perpetual motion machine *9* 15
Pesticides: DDT residues *9* 26; resistance *11* 30; safe *7* 13; testing *6* 13
Phatak, V. K. *4* 33
Phatnani, Pritam *1* 63; *2* 58; *3* 52; *4* 68; *5* 68; *6* 66; *7* 64
Pheromones, insect *7* 30
Phondke, G. P. *2* 27; *5* 56; *11* 40
Photographing an eclipse *2* 47
Photosynthesis, electricity generation *9* 25
Physical Research Laboratory *9* 6;
Physics: matter, constituents of *10* 29; nuclear *9* 7; solar *9* 7; unification theories *3* 43
Piezoelectric displacement measuring *2* 55
Pillai, Shiv *2* 25
Pitts S-2A biplane *9* 62
Planetary rings *5* 24
Plank's constant *5* 47
Plastics behaviour in zero g *7* 15
Pollution: SO_2 *9* 41; transboundary *9* 39
Polyominoes *5* 63
Pradhan, D. S. *2* 57
Pradhan, H. C. *6* 35
Prakash, Bhartendu *11* 42
Preserved foods, cancer hazards *3* 35
Prime numbers, dividing by *8* 67
Proton decay *3* 51
Pseudo-science: danger of *3* 7; sociobiology *11* 8
Pushparaja *6* 41
PWD building schedules *7* 7
Pyrethrum analogues *7* 13

Qasim, S. Z. *9* 23
Quarks: model *10* 32; nucleon-nucleon interaction *5* 31
Quasars: *8* 26; anomalous redshift *5* 33; double, gravitational lens *5* 7; triple *8* 31; quintuplet *9* 14

Quiz: aerobatics *9* 59; birds *11* 55; genes and heredity *8* 57; geology *10* 40; health and disease *5* 57; microbiology *6* 45; smoking *4* 65; textiles *3* 57

Rabbits for food *1* 15
Rabies: *9* 51; vaccine *8* 17
Rabi, Isidor I. *9* 11
Radiation protection in nuclear medicine 6 37
Radiosonde thermistor *3* 41
Raikar, R. N. *4* 36
Railway tracks *6* 61
Rainfall in India 6 6
Raja, Jay *2* 56; *7* 37
Rama *2* 63; 6 7
Ramadurai, S. *3* 37; *7* 28; *8* 31; *10* 26; *11* 35
Ramani, S. *3* 70; *5* 59
Rana, N. S. *2* 47, 50, *6* 51
Rangachari, S. S. *2* 65
Rao, M. A. P. *7* 37
Rao, M. N. *11* 35
Rao, N. S. Vasudeva 6 61
Rao, P. S. *11* 36
Rao, T.R. *11* 31
Rege, M. S. *11* 34
Research & development: grants *7* 15; expenditure related to GNP *7* 41; industrial design *7* 43
Research institutes: AIIMS *3* 7; PRL *9* 6; EMBO *10* 22
Rivest-Shamir-Aldeman encoding scheme *7* 21, 22
Rocket technology, India *8* 13
Rosencranz, Armin *9* 39
Roy, Amit *2* 28
Roy, Dilip K *4* 44

Sadanandan, P. *5* 49
Sagar, Prem *8* 34
Salam, Abdus *3* 48, 50
Saldanha, M. *8* 65
Salmonella *6* 47
Sampemane, Sumati *3* 17; *5* 19; *10* 24
Sanjeeviah, H. *7* 51
Sankaran, M. P. *4* 24
Sarma, K. V. L. *6* 25
Saturn, rings of *5* 24
Saxena, K. N *7* 35
Schmitt trigger *5* 71
Science: and the press *7* 9, dogmatic beliefs *8* 72; education *1* 49; *3* 9, *5* 36, *8* 7; 8 7, 10, *9* 45; method *see* Method of science, policy *3* 15; *5* 9; *7* 39, 42; *9* 4; 9 9; plagiarism *7* 14; pseudo *3* 7; *6* 7
Science & Technology: alternative perspective *10* 67; change of attitude to *6* 8, policy and planning in India *5* 9, *7* 39, 42, policy in China *6* 29; relevance to village poor *11* 44
Scientific: papers, piracy *7* 14, temper and public policy *5* 9
Scientists (In lighter moments)
Bohr, N *7* 29; Boyle, R. *4* 25 Carroll, L. *11* 37; Darwin, C. *3* 39; Descartes *4* 25; Ehrlich, P *9* 27; Einstein, A. *5* 35; Fermi, E. *7* 29; Galileo *1* 57, *4* 25; *5* 35; Galvini, L *1* 57, Gregory, D *11* 37, Guericke, O. *2* 29, Haldane, J. B. S. *3* 39; *11* 37; Heisenberg, W *2* 29, *5* 35, *7* 29; Helmont *11* 37; Herschel, W. *6* 27, Hilde brand, J. *8* 40; Hooke, R *10* 28, Huxley, J. *3* 39; Knight, T. A *6* 27, Koch, L *3* 39; Lalande, M. *4* 25; Lamarck *3* 39, Le Corbusier *6* 27; Leibnitz *4* 25, *10* 28; Malthus, R. *11* 37; Neumann, J. *8* 40, Newton, I. *4* 25; *7* 29; *9* 27; *11* 37; Paracelsus *7* 29; Pasteur, L. *2* 29; Rumford *8* 40; Settle, J. *4* 25; Simpson, J. *3* 39; Szent-Gyorgyi, A. *5* 35; Thompson, B. *8* 40; Volta, A. *1* 57; Weil, G. *7* 29, W[illegible], E. *7* 29; Wood, R. W. *10* 28
Scientists: frustration among *8* 7; landmarks in history of science *5* 60
Seetharam, K. *10* 69
Sengupta, A. N. *1* 43
Senility and aluminium *6* 11
Sen, Jai *4* 44
Sethna, S F. *10* 45
Sex: attractants *7* 32; differentiation *8* 57, 58; differences in the brain *6* 53

Seyfert galaxies *8* 25
Shah, Narottam *6* 29
Shanker, R. *5* 33
Shardanand *9* 8

Sharma, P. *4* 21
Shenai, V. A. *3* 59; *7* 61; brain teasers *1* 43, *3* 41; *5* 49, *7* 68; *8* 71, *9* 59; *10* 69 ; *11* 43
Shirodkar, M. V N. *8* 34
Shiva, V. *10* 69
Siddiqi, Obaid *1* 27, *8* 16; *11* 41
Silent Valley *5* 44, *8* 9
Silicon controlled rectifier *4* 75
Singbal, B V. *2* 28; *10* 63
Singh, B. P *7* 27

Singh, Harwant *2* 57
Singh, Rajvir *11* 49
Singh, Satpal *10* 24
Singh, U. N. *1* 13
Singh, Virendra *1* 23; *3* 51
Sitaraman, S. *4* 71
Sivanand, Mohan *4* 12
Sivaprasad, N *7* 61
Sivaramakrishnan, M M *2* 13, *8* 54; *9* 62
Skin ridge pattern *6* 15
Sky, why it is black at night *7* 51
Slums: *4* 40, *7* 7, Calcutta bustee improvement *4* 44; Delhi squatters *4* 44
SLV-3 *8* 13
Smallpox *6* 11
Smoking: low-tar cigarettes *10* 13, quiz *4* 65; 'stop stone *6* 12
SO_2 pollution *9* 41
Social space *1* 15
Society of Young Scientists *4* 54
Sociobiology, behaviour *3* 23, 28; in India *3* 31, pseudo-science *11* 8
Sodd's law *2* 13, *5* 7
Solar eclipse: *2* 31, behaviour related to *3* 17; effect on the earth's atmosphere *2* 51; goggles *5* 37, photography *2* 47
Solar, poles *9* 14, pump *1* 12
Sondhi Committee report *4* 11
Sonochemistry *9* 37, *11* 8
Space research, India *8* 13; technology, China *3* 19
Sperm bank, Nobel laureates *4* 12
Spontaneous generation *6* 47
Sridharan, R *2* 65
Srinivasan, C *9* 37
Srinivasan, S *2* 65
Stars, double *8* 69; shells around galaxies *8* 30
Stereo power level indicator *11* 71

Street life *11* 58
Stress: and reproduction *4* 13; thermal, effect on workers *5* 66
Subbaratnam, T. *6* 41
Sugar, molecule *2* 19
Suicide, Jonestown *3* 21
Sun: anatomy of the *2* 36; companion *8* 69, corona *2* 41, ring around *2* 15; shrinking *7* 28, spots *2* 39

Subrahmanyam, D *11* 29
Superconductivity, high temperature *11* 33
Supernovae *3* 56, *6* 26; *8* 22
Surge comparison tester *4* 51
Surolia, A. *2* 25
Surya Jatras *5* 39
Suryanarayana, S. *11* 22
Swaminathan, M S *7* 54
Switch, tuned whistle *2* 73, *3* 72

Talwar, S. S. *11* 36
Tampons, death due to *8* 18
Tarafdar, S. P. *8* 30
Tears *9* 14
Technology, indigenous and foreign *7* 43
Telephone, writing by *8* 17
Teratorn *11* 14
Tex *7* 7
Textile quiz *3* 57
Thammana, Pallaiah *1* 27
Thermal stress effect on workers *5* 66
Third world and UNCSTD *9* 30
Thomas, Paul *6* 35
Tidal power *9* 20
Time, unidirectional *6* 49
Tissue typing *8* 57, 58
Tobacco smoking quiz *4* 65
Tooth decay *10* 27
Trains, aerodynamics of *8* 54
Transformer, welding *9* 37
Transistor miniaturisation *7* 13
Tribhuwan, R. C. *2* 57
Tumour formation in cells *4* 24
Twilight lamp *5* 70
Twins, heredity studies *6* 12

Udgaonkar, B. M *5* 15
UNCSTD *9* 29
Universities and Science (Delhi) *3* 9
Unification of basic forces *3* 43
Unified field theory *1* 19
Uranus, rings of *5* 26

Urban spaces, utilising *11* 58

Urine, drug from *1* 15
Urokinase, clot disolving enzyme *6* 11

Vaccines: burn infection prevention *2* 16, foot-and-mouth disease *4* 15; general *5* 54; *see also* immune system *5* 50
Vasectomy, hazards *8* 17
Venkataraman, B. *5* 34
Venkatavaradan, V S *9* 55
Vibrations: *11* 16, Forced *11* 18, Free *11* 17, and human body *11* 20
Vidnyan Jatra *80* 7 46
Viral diseases *9* 51
Virus, flu *4* 15
Vitamin B_{12}, intestinal synthesis *4* 23
Vohra, K G *4* 59

Watches, radium dial *9* 5
Water level switch *1* 69; pipes as earthing *3* 62
Waves *see* vibrations
Weinberg, S. *3* 48, 50
Weizenbaum, Joseph *6* 9
Welding transformer *9* 37
Weyl, Hermann *3* 47
Whales, killer *6* 5
Work addiction *8* 19
Whyte, William H. *11* 63

X-chromosomes *4* 14; *10* 14
Xerographing X-rays *7* 37
X-ray: astronomy *8* 21; image duplication *7* 37

Yang, Chen Ning *3* 44, 45
Young scientists, symposium *4* 54
You too can do it: Automatic twilight lamp *5* 70; Emergency light *8* 75; Fuel level indicator *9* 65, LED stereo power indicator *11* 71, Muscle stimulator, solid state *8* 61; Musical dancing lights *6* 65; Remote control, whistle tuned *3* 72; Rechargeable torch *10* 77; regulated DC supply *7* 67; Smoke alarm *4* 75; Water level switch, solid state *1* 69
Yukawa, Hideki *3* 45; *5* 31

Zero, if there were no *10* 62
Zimbabwe, origin of *6* 12

HOUSING : SOME SOLUTIONS

YOUR April 1980 issue focussing attention on low-cost housing was timely In spite of quite a few innovations being achieved by the Central Building Research Institute, Roorkee, and other institutions, the sad part is that the results have not reached the consumer to the desired extent This gap in communications could perhaps be solved by introducing low-cost housing technique as a subject at high school or junior college As the fundamentals of this subject do not involve complicated mechanics or mathematics, they can easily be comprehensible to anyone owing elementary thematics and science

A lot has been written about housing the urban poor by providing them with ure of land It is even gested to divide plots narrow as 30 to 50 sq m this purpose (Mr Phatak o suggests this in his arti) It should be noted that nd especially in met politan areas like Bombay l Delhi, has become too precious due to the overall pressure on it The more practical and feasible solution would be to accommodate these hutment dwellers in well-planned, economically built, four or five-storeyed buildings and to utilise the balance available land for housing more people of the upper class

The salvage value of land thus available would more than compensate the subsidy of providing better housing to the hutment dwellers Our technique for constructing four/five storeyed buildings in a more economical way requires to be changed drastically The conventional brick partitions can be replaced by gypsum partition-boards which are very light and convenient for speedier erection More experiments are also required to improve and popularise concrete frames in view of the soaring prices of wood The deteriorated quality of bricks requires to be improved so as to make cheaper the external facade of load-bearing walls

Punitive measures must be taken against engineers for not utilising the proven new techniques and materials for which there are national and international standards The basis for constructing traditional buildings are the specifications drawn by the Public Works Departments at the centre and various states We should burn them and draw specifications based on new techniques and innovations developed in the various national laboratories Or else, close the laboratories once and for all

Jaswant B Mehta
203 Walkeshwar Road
Bombay 400 023

"BURN PWD BUILDING SCHEDULES"

HOUSING the millions is not an insurmountable task Priorities are given by the government based on mass agitations In the absence of it, priority is not there

Burnt lime, strengthwise, qualitywise and quantitywise, is not as cheap as imagined by many The cost of production of cement works out lower It is excise duty, sales tax and gunny bags that make cement costly

By adopting the new techniques (which often do not get beyond seminars), cement and steel could be saved Further, by making it obligatory on all consumers to use fly-ash in all constructions and utilising all the blast furnace slags in the manufacture of slag-cement cement shortage could be overcome

Instead of advising villagers and slum dwellers to go in for mud walls and floors, cement should be made available As there should not be two categories of citizens in India there cannot be two standards for constructing houses—one for the rich urban and another for the poor rural

S Mallikarjunaiah
Prayoga, Upper Hutha
Bhadravathi (Karnataka)



Well? Better housing! You haven't shouted slogans, misbehaved. Do you really need better housing?

BETTER DEAL FOR SLUM DWELLERS

WHILE Vivek Monteiro's article How to take science to the masses' (May 1980) was most informative, I beg to differ with his views on slums Legalising slums and providing them with water connections and electricity are not going to solve the slum dwellers problems the way Monteiro thinks Why allow slums to occupy vast areas when skyscrapers can help ease the pressure on urban land? So it would be better for architects and environmental engineers to work out possible low-cost multi-storeyed housing schemes Proper housing will bring better health and family life

R N Deshpande
586 Sadashiv Peth
Poona 411 030

GENES AND BEHAVIOUR

THE CONCEPT of the selfish gene is unreal (The Evolution of Behaviour, March 1980), being based upon a view of life as *nothing but* DNA, genes or genotype It overlooks the basic fact that an organism—be it a lowly bacterium—is much more than a mere bundle of genes. The primacy of the genetic material in its self-replicating and controlling function cannot be denied, but it has to be admitted that for expressing these functions, DNA needs the prior existence of enzyme-proteins The actual expression of life is in the integrated manifestation of its dual function as represented by the genotype and the phenotype

The unreality of the first viewpoint can be illustrated by the famous statement of Butler that 'the hen is the egg's way of making another egg If that is all the truth there is in biology, such a general view is useless, for it explains nothing of the diversity of life

It is well known that the social lives of such living things as bees, ants birds etc are determined largely by comparatively rigid genetic structures (though even these are, to a variable extent, flexible, being affected by environmental conditions) Higher up in the scale of animal life, however, the patterns of response become more flexible As Dr Nanjundiah points out, there is an increasing complexity in the mechanism, and with the appearance of man there is a qualitative difference The very evolution of man as *human* depended on cultural differences and on the ways in which he organised into societies This factor underlies the origin of much of his behaviour

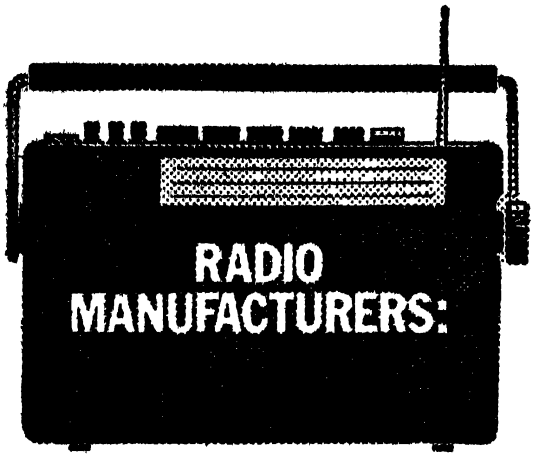
Geetha Bharathan
Junior Scientist CMFRI
Madras 600 015

"TEX" IS LIGHTER

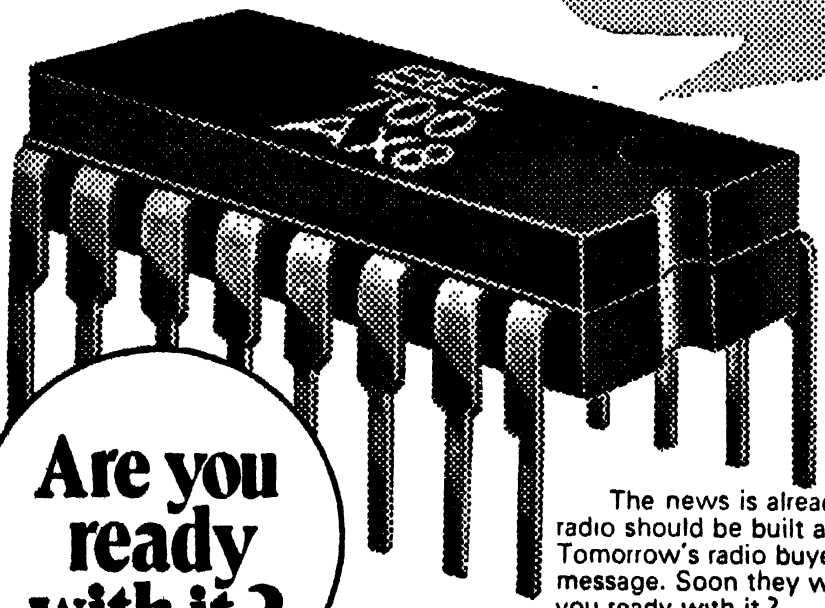
IN THE answers to the textiles quiz (March 1980), the term 'tex has been defined as the weight in grams of 10 000 m of a yarn Actually it is the weight of 1,000 m (one kilometre) of the yarn

R N Yadav
Sujata Textile Mills
Nanjangud 571 301
Karnataka

Dr Shenai writes. *The tex is the weight in 1,000 m of the yarn. The error is regretted*



From tomorrow buyers are going to demand the radio of the future



Are you ready with it?

Ask BEL about IC radio circuitry and BEL-700 IC

The news is already broadcast that the most advanced radio should be built around the latest BEL IC technology. Tomorrow's radio buyers have tuned in and got this message. Soon they will be looking for the IC radio. Are you ready with it?

If you have second thoughts, just listen to us. Radios built with ICs offer these additional advantages :

- **High sensitivity is maintained even when the battery voltage drops.**
- **Built-in stabilisation circuit is provided.**
- **Circuit is protected in case of short circuit of output terminals.**
- **Miniaturisation with maximum advantage.**
- **Rugged and hardy in use.**
- **Comparable performance at competitive prices.**

If you thought solid state was a revolution, IC radio is way ahead the world over.

Tune in to the demanding consumers' voice. Get ready with your IC radio. Ask BEL what they can do to make your brand of IC radio a listening pleasure.

BEL–leaders in professional electronics

Write to : Chief Sales Manager (Components), BEL, Jalahalli, Bangalore-560 013.

BHARAT ELECTRONICS LTD.
(A Government of India Enterprise)
Bangalore • Ghaziabad • Pune

CAS-BEL-8044

Is our press blind to science?

WHEN Muhammad Ali, "the greatest", visited India recently, it was a big event for most of our daily papers. The front page coverage he received was perhaps in tune with his achievements in his chosen field of endeavour. In contrast, however, was the reception accorded to another group of distinguished visitors, a galaxy of scientists who were in Calcutta during December 1979. Their visit was ignored by the press. Comparison with Muhammad Ali was only incidental; almost anything, the antics of a minor politician, the passing away of an old India hand in some obscure corner of England, or a music conference in Tiruchirapalli, may get precedence over events related to science in our press. Take, for instance, some recent events—the splitting up of a premier scientific organisation like the Council of Scientific and Industrial Research, the passing away of that father figure in modern organic chemistry, R. B Woodward, or a scientific conference like the 20th International Conference on Co-ordination Chemistry held in Calcutta in December, 1979

Considering the overwhelming influence science has on the growth and shaping of the present day society, the situation is paradoxical indeed. Perhaps it is the direct consequence of the existence of what C. P. Snow called the Two Cultures, and the complete identification of our press with the non-scientific culture.

The role of science in the shaping of our everyday life is self-evident. Various electronic gadgets, newer modes of communication and transport, and new and powerful drugs continuously interact with daily human activities and affect human life style. These reflect the functional importance of science. On a higher plane, scientific advances influence national policies, international relations and the existence and welfare of the human race as a whole. To give an example, who knows what would have been the course of world history and international relations if the atomic bomb had been perfected in Germany instead of in the United States. Even today, the two superpowers derive much of their prestige and power from their scientific and technological lead over the rest of the world. And a part of the credit for our rising stock, [illegible]

tries, must be given to our scientists, technologists and farm scientists.

Besides, in its own right, science is a part of human cultural heritage just as art, literature and drama are. Just as poetry, painting and music are expressions of the creative genius of mankind, so is science a triumph of human endeavour over the environment. Science is thus as important a human activity as any other. And it deserves as much coverage, critical appraisal and interpretation by the press as other spheres of human activity. Yet, leaving aside a few imaginative but isolated attempts, science, in spite of all its attributes, has remained a blind spot with our press.

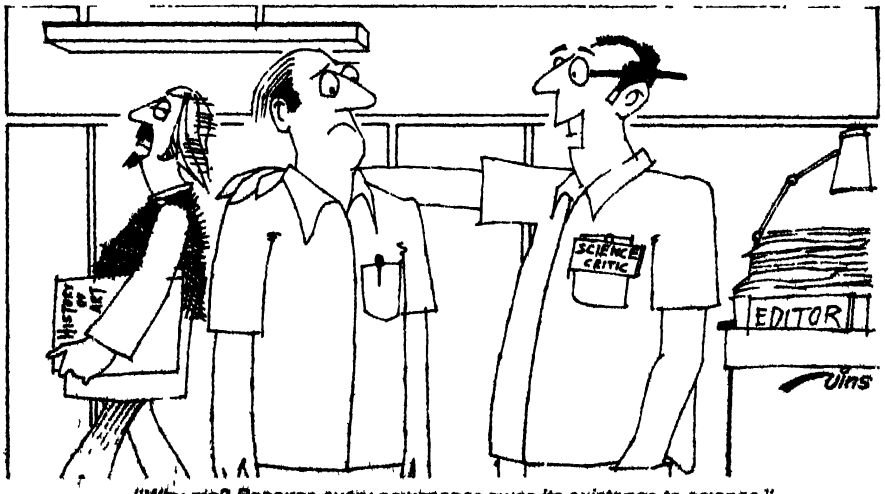
Why is this so? One is tempted to ascribe the present state of affairs to the commonly shared background of arts and literature by most of our media men. They are generally well equipped to understand and appreciate developments in politics, arts, literature or economics. Their grasp of these fields is further consolidated by moving among political, economic and social leaders of our society. But very few of the journalists have even a nodding acquaintance with science and scientists. Consequently, there is no question of following a hunch, digging material and developing a news story concerning science. Their training, adequate as it is for interpreting elements of non-scientific culture, leaves most of the media men wholly unprepared for understanding the significance of happenings in the domain of scientific culture. As Snow observed in another context ".....those two revolutions, the agricultural and the industrial-scientific, are the only qualitative changes in social living that men have ever known. But the traditional culture did not notice: or when it did notice, did not like what it saw.....it (traditional culture) trained its young men for administration, for the Indian Empire, for the purpose of perpetuating the culture itself, but never in any circumstances to equip them to understand the revolution or take part in it".

Technical background

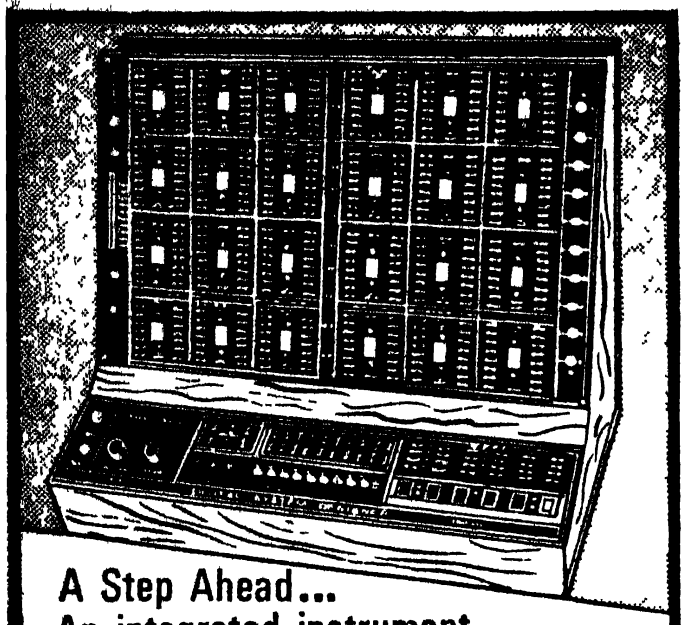
One reason often given for the poor coverage of science news in our press is that it is difficult to follow and requires some technical background for appreciation. But all science news is not technical. And, are similar difficulties not associated with some of the other activities regularly covered by the press, for example, art and music? A vast majority of readers do not know what *laya* or *taal* means. But this does not deter newspaper editors from employing regular staffers who turn in columns after columns appreciating the technical niceties of individual performers and performances.

This is not to suggest that there is anything wrong with this, but just to emphasise the fact that the existence of a class of intelligent readers is recognised and the need to educate others about an important aspect of human activity is fulfilled. One wonders why the same consideration cannot be extended to science.

In publishing science news, two major objectives should be: (i) to satisfy the curiosity of readers about the laws of nature, and (ii) to make them aware of the long-term influence of science on society, making national science policies (or lack of these) a matter of general public concern. The recent total solar eclipse afforded an excellent opportunity of the first kind. However, the type of coverage that was provided by our



"Why me? Because every newspaper owes its existence to science."



A Step Ahead...
An integrated instrument for integrated circuits...
AEC DIGITAL SYSTEM DESIGNERS

MODEL DSD-3

Versatile and self-contained laboratory demonstrator Plus a digital system development instrument to conduct simple and advanced experiments in combinational and sequential logic circuits. Using III and IV generation ICs. for training and simulating industrial designs.

ADVANCED AND EFFORTLESS

For quicker, neat and efficient breadboarding of digital logic gates to develop, build and test complex systems before constructing prototypes.

Using 24 numbers of 16-pin dual in-line IC sockets and a 22-pin edge-connector for solderless interconnections and disconnections
Also can be used as Dynamic Digital Integrated Circuit tester under actual operating conditions.

COMPLETELY SELF-CONTAINED

* Contains everything needed to assemble, test the logic circuits
* Built-in input signals and output indicators, such as power supplies, clock signals, pulsers, logic status indicating lights, logic switches and digital displays.
* Eliminates cumbersome and maze of component boxes, separate power supplies, pulse generators etc.

A MUST FOR EVERY ADVANCED ELECTRONICS LABORATORY ENGAGED IN TRAINING AND DEVELOPMENT OF DIGITAL CIRCUITS.

MODEL DSD-4

Similar to DSD-3 except that it has·

* 16 Nos. of 16-pin Dip Sockets
* 4 Nos of 24-pin MSI/DIP Sockets

SUBRA & RAM A 2

For further particulars, please contact:

ALLIED ELECTRONICS MFG. CO.
337, Thambu Chetty Street, Post Box No 203
MADRAS-600 001 Phone 422269/445904/423368

camel ink

In six inspiring shades for smoother flow and beautiful clean writing.



S 801

press seemed only to create a scare among the masses. It is doubtful if many readers got educated on the scientific aspects of the phenomenon. Typical of the issues that could be covered under the second category is the national policy on energy. For a country like India, with its substantial coal deposits, is the present oil-oriented energy policy in need of reorientation? What are the problems and achievements of India's nuclear energy programme? Or, are we spending too little or too much on basic research in terms of the returns we seem to be getting? These and other science policy issues should be open for public debate. Only the press can initiate and catalyse such a process.

Generally, scientists and science are considered newsworthy only on rare occasions when a spectacular event like moon-landing (or launching of a satellite or a nuclear explosion in the Indian context) takes place. And these occasional waves of excitement die very soon. One may argue that apart from the spectacular events of the kind cited above, there is nothing in science to excite the reader's interest or which can make a good story. Though the spectacular cannot happen every day, it is the culmination of a sustained and collective effort by a group of scientists over a long period of time. This everyday effort of the scientists, its failures and successes and its implications are worthy of attention.

Dr. Joel H. Hildebrand, writing in his book *Science in the Making*, stresses two aspects of science: "I distinguish two aspects of science: one may be designated content, the other enterprise. The one, as the dictionary says, is classified knowledge; the other is the ways in which scientists work and think. The one is the way we write up our results, in papers and books, in passive voice, giving the impression that we start with precise measurements and proceed by strict logical steps to incontrovertible conclusions. The other is the way we really do it—starting with hunches, making guesses (most of which prove to be wild), making many mistakes, going off on blind roads before hitting on one that seems to be going in the right direction. This is science in the making." It is this science in the making which should be reported and interpreted for the general reader. It has all the elements of a good story but remains unexploited due to a lack of understanding and interest on the part of the Fourth Estate.

Scientists themselves are also partly responsible for the present state of affairs. They take little interest in the dissemination of scientific knowledge for the common man. Very few of them seem to be willing to take a direct part in the process. They have not helped the media, either, to portray a correct and factual picture. In particular, leaders of science can play a major role in helping the press in giving objective coverage to events, activities, achievements and personalities. There have been instances of exaggerating favourable news or suppressing unfavourable ones. But, again, this behaviour is not peculiar to scientists alone. Pressmen are confronted with the same problems in many other fields of their endeavour.

Admittedly, Indian scientists are no trend-setters, but can we afford to ignore their activities? To us, what is happening in the scientific field in India should be of as much relevance and importance as Indian literature, Indian art, Indian music, etc, though in none of these fields are we anywhere near the top. In fact, the shortcomings and strengths of Indian science, its direction or lack of it, should be made a concern of the general public. This can be done only if our press takes more interest in science and scientists.

B. C. SHARMA

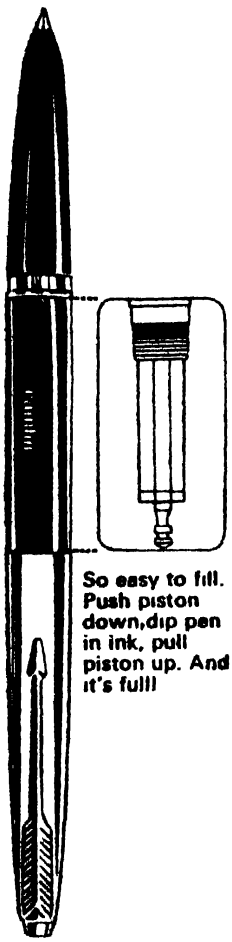
Dr. Sharma is with the Publication and Information Directorate of [illegible] Research, New Delhi.

new

UNMATCHED

camlin
PISTON PENS

No time wasted. No messing up with ink. Camlin Piston Pen mechanisms make it just easy. Fill up and feel the difference.

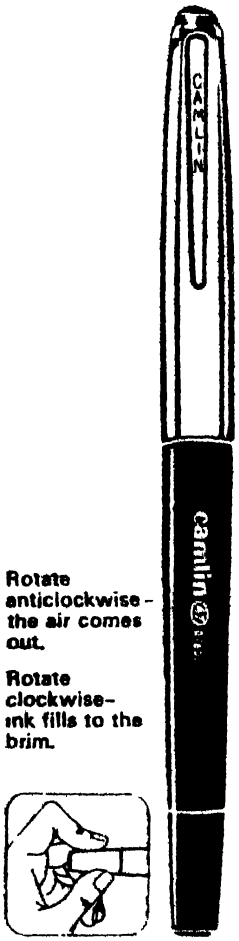


So easy to fill. Push piston down, dip pen in ink, pull piston up. And it's full!

INJECTION PISTON PEN 48

Rotate anticlockwise - the air comes out.

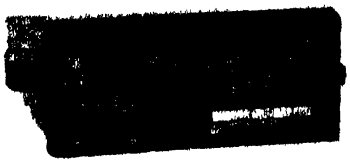
Rotate clockwise - ink fills to the brim.

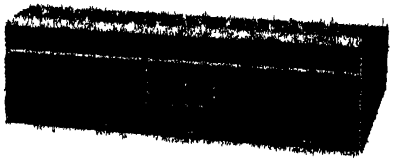


PISTON FILLING PEN 47

S 793

IMPORT UNDER OGL THE-STATE-OF-THE-ART BRIDGES





252 Automatic measurements at 1 kHz frequency

L 0 1 μH to 200 H G 0 001 μS to 2000 mS
C 0 1 pF to 200 μF D 0 001 to 1 999
R 0 001 Ω to 2000 kΩ

253 Automatic range selection at 1 kHz test frequency

L 0 1 μH to 200 H G 0 001 μS to 20 S
C 0 1 pF to 2000 μF D 0 001 to 1 999
R 0 001 Ω to 2000 kΩ

254 Semi-automatic measurements at 120 Hz test frequency

L 1 μH to 2000 H G 0 001 μS to 20 S
C 0 001nF to 20 mF D 0 001 to 1 999
R 0 001 Ω to 2000 kΩ

296, 296V, 410 Automatic Digital RCL Meter

These instruments provide high-speed testing and sorting of components The microprocessor based meters are ideal for virtually all manual or automatic component testing applications Functions ranges test voltages and frequencies are easily selected on the front panel keyboard or can be programmed through optional interfacing with IEEE 488 1975 teletype or card reader Displays can be set to indicate either actual value or deviation from a programmed nominal value in absolute or percent deviation For component sorting 10 programmable limits are available (11 with the 296V and 410)

Features include Dual 4½ digit displays (simultaneous C & D) 0 1% basic accuracy Auto ranging 63 ms 300 ms measurement speed Interfaces with automatic component handling equipment DC resistance option on 296 allows simultaneous measurement of in

296, 296V Dual frequency – 1 kHz and 120 kHz (Optional to 20 kHz available Consult factory)

L 0 001 μH to 2000 H at 1 kHz,
0 01 H to 20 000 H at 120 Hz
C 0 01 pF to 0 2 F at 1 kHz
0 1 pF to 200 000 μF* at 120 Hz
R 10 μΩ to 125 66 kΩ (2MΩw/DC option)
Q Calculated as 1/D
D 0 0000 to 1 9999

* Expandable to 2 F by programming special test mode functions

410 1MHz test frequency

L 0 0001 μH to 20 mH Q Calculated as 1/D
C 0 0001 pF to 20 nF D 0 0000 to 1 9999
R 10μΩ to 125 66 kΩ

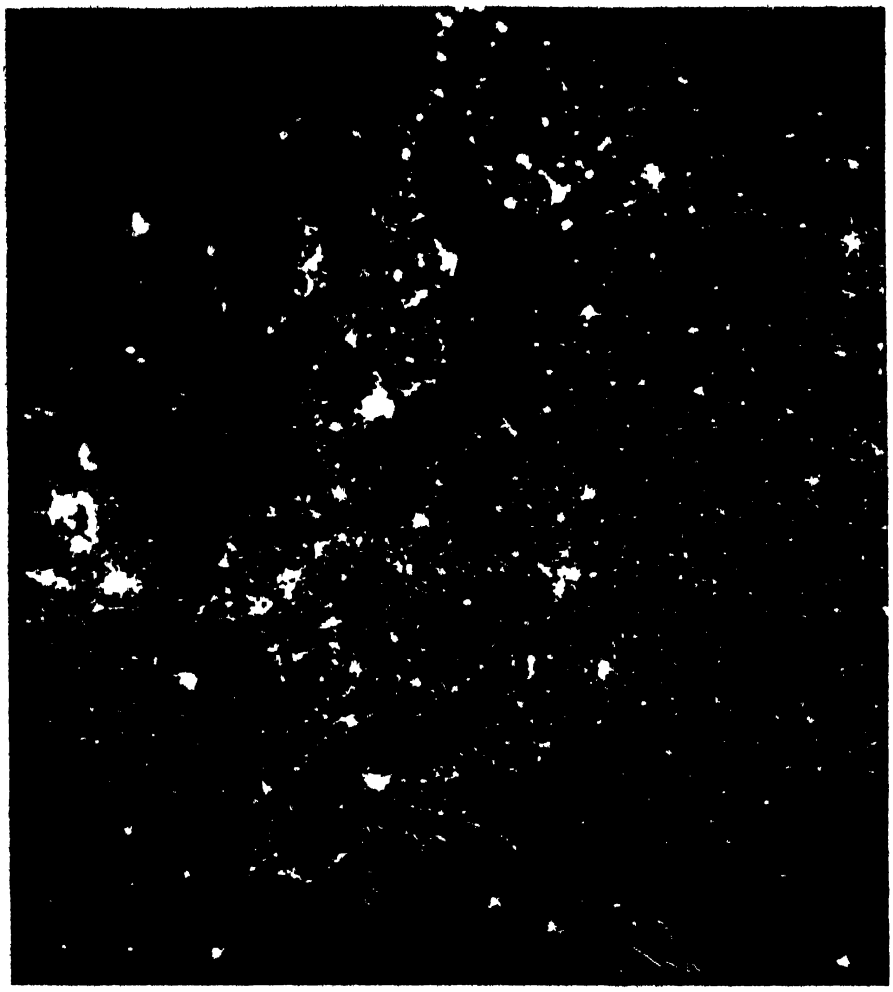
The reference Standards of measurement of ESI are compared with the U S National Standards through frequent tests by the U S National Bureau of Standards ESI offer precision capacitance & resistance measuring systems resistance standards, decade resistance boxes ESI — No 1 in LASER TRIMMING offer total system solution

esi ELECTRONIC ENTERPRISES, P B 6367, Sewri, Bombay-15 Tlx 011-2971-ELEN-IN
Electro Scientific Industries, Science Park Drive, 5 Portland, Oregon

---



Science Shapes Life



NIGHT FLIGHT OVER EUROPE

Recognise any constellation in the above picture? Don't try too hard since it's bound to be futile; this isn't a picture of the starry night sky but a mosaic of several light images of Europe at night from 833 km above. Taken by the US Defence Meteorological Satellite, the photo shows Europe and western USSR. A discerning reader could probably tell the shape of the British Isles at the left, Scandinavia (top) and long-legged Italy (bottom). Arrows show the major cities A: London, B: Paris, C: Milan, D: Copenhagen, E: Helsinki, F: Leningrad, G: Moscow, H: Kiev, I: Warsaw, J: urban areas of East and West Germany, K: Italian peninsula.

The satellite's camera has a resolution of 3.2 km. The dotted lines such as that between Kiev (H) and Warsaw (I) represent towns along highways or railroads.

PROBLEMS OF SHRINKING TRANSISTORS

Ever since the process of integrating thousands of transistors in a small chip of silicon was developed in the late 1960s, miniaturisation proceeded at a fantastic pace. At present transistors can be packed on a chip at a density of 65,000 or more per square centimetre. These chips are fabricated to function as the central processing units and memories of microcomputers. Very large-scale integration (VLSI) was made possible using silicon gate MOS (Metal Oxide Semiconductor) technology. How much smaller can transistors get? According to a report (*Science* 208 1246), VLSI circuit designers are facing problems in shrinking the transistor further.

The main limitation concerns the width of the silicon gate and conducting strips that connect the gate to the rest of the circuit. The smaller the cross-sectional area of a conductor the larger is its resistance to current flow. In VLSI circuits, the width of the silicon conducting strips approaches 1 micrometre; their resistance increases by a large amount reducing the efficiency of the high speed circuits.

Another problem of miniaturised transistors is damage by high energy nuclear particles passing through the microcircuits. Alpha particles are produced as the trace quantities of radioactive uranium or thorium in the packaging that houses the chip decay. Alpha particles are also produced when neutrons interact with silicon atoms; neutrons are among the resulting elementary particles from cosmic ray interaction with nuclei of molecules in the upper atmosphere. These alpha particles travel through the circuitry and ionise silicon atoms on the way, producing a wake of charged particles. Semiconductor computer memories consist of thousands of 'cells'—a cell being made up of a transistor and capacitor. Each memory cell has a particular location or set of co-ordinates in the array of cells and can store one bit of information represented by a charge or the absence of charge on the capacitor. A charge on the capacitor may represent binary 1 and zero charge, binary 0. The transistor acts as a switch to allow the capacitor to charge or discharge and connects the capacitor to its particular data line. Thus, the charged wake of alpha particles could cause the capacitor to change its state, resulting in wrong information when the memory cell is recalled.

Other limitations regard the presence of high electric fields in small devices and dissipation of the heat caused by switching. Semiconductor devices being heat-sensitive, accumulation of heat in a densely packed chip can result in breakdown of the circuitry.

The search for solutions to these problems could result in a whole new class of devices as well as new methods of studying phenomena brought about when thousands of transistors are fabricated on a miniature chip.

SAFE PESTICIDES

A daisy-like East African flower, pyrethrum, has been the source of the powerful natural pesticides known as pyrethrins. Potent, yet non-poisonous, pyrethrins are expensive to produce and are not chemically stable when exposed to light and air. This spurred scientists to produce cheaper synthetic analogues with better stability.

The world's oldest agricultural research institute, Rothamsted Experimental Station in England, has successfully produced a range of new synthetic pyrethrin analogues. While pesticides are generally powerful environmental pollutants, these new pyrethroids, which are 100 times more potent than DDT, are without the long-

term ill-effects associated with chemical control The United Nations and the World Health Organisation are yet to okay these compounds A spokesman of the WHO expert committee responsible for the final testing said that the compounds were among the most active insecticides known Sixteen synthetic pyrethroids have so far been tested in the WHO programme The unit cost is high but their cost effectiveness may be acceptable This and their effects on non-target organisms will be critical for the acceptance for (disease) vector control"

The new compounds are comparable to the natural pyrethrins in their safety to man, they are readily metabolised when swallowed by mammals They are chemically far more stable to air and light than the natural compounds and also more deadly to insects and easily break down in the soil However, there are some drawbacks the compounds kill beneficial insects like bees and are also toxic to fish and will therefore need careful handling Once the UN and WHO okay their use several West European, North American and Japanese companies will go into largescale production

The compounds will be used to control insects which transmit malaria, yellow fever, bubonic plague, sleeping sickness and megacardia It will also be used extensively in agriculture and crop storage But there is no telling when insects will develop immunity to them Perhaps, by then we will have unravelled the mechanism of insect resistance

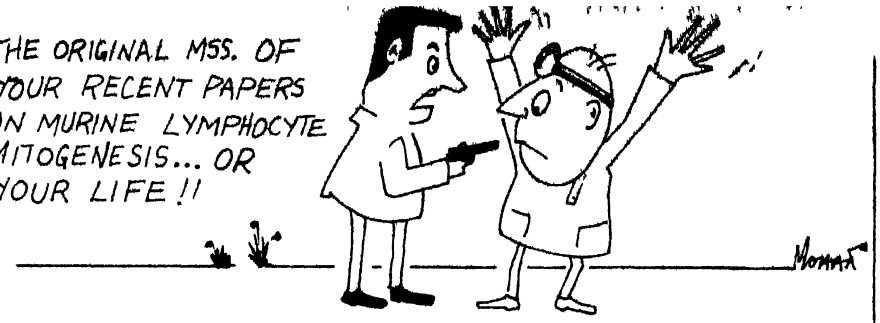
INTERFERON TRIALS

Although cancer researchers are gaining more and more evidence on the activity of interferon (a new anti-cancer drug) it looks like it is too early for the last word on it

Recently, much has been written and said about this wonder drug But what exactly are the results? Preliminary results of interferon use in the USA have been revealed a few weeks ago by Frank Rauscher, vice-president of the American Cancer Society

According to him, interferon (made from human white blood cells) reduced breast cancers in seven out of 16 patients Also, in three out of 11 people with bone marrow cancer (multiple myeloma), the disease completely disappeared This is not as spectacular as the results we hear of from Europe, especially Sweden, and perhaps only serves to confirm the anti-cancer activity of the drug

Another bit of news on interferon trials comes from the University of Wisconsin Medical Center It says 16 breast cancer patients with no previous treatment received interferon injections, of which five showed partial response, while two showed measurable reduction in tumour size The patients showed the side-effects normally associated with interferon treatment—high temperature, weakness and reduction in white blood cells On the other hand, the response of multiple myeloma patients was not so encouraging Of 11 patients, only three improved, with the patient who responded best suffering from severe side-effects which included anaemia and abnormal liver function



THE MYSTERY OF THE PAPER PIRATE

Last year the *European Journal of Cancer* published a paper by two Americans, D Wierda and T L Pazdernick, on the effects of platinum on T-lymphocyte function About the same time, the *Japanese Journal of Medical Science and Biology* published a paper entitled 'Effect of platinum on murine lymphocyte mitogenesis' The two papers are almost identical in content

Recently there have been many incidents of piracy in scientific literature One common feature in all the pirated papers is the name Alsabti Alsabti is a prolific paper writer, according to the *Index Medicus*, Alsabti published 13 articles last year and 10 during the first five months of this year Who is this brilliant scientist anyway?

Even an eel would be like a roll of sandpaper when compared to slippery Alsabti In the Japanese journal, K A K Alsabti's address is given as the Royal Scientific Society Amman, Jordan The Scientific Attache at the Jordanian Embassy in London was unable to furnish details about his whereabouts and said that the Royal Society no longer permitted the scientist to use its address

Another lead to follow was the address where requests for reprints were to be made This, too led to a blind end

The now-retired editor of the Japanese journal could not remember processing the paper A note to the article had said that it was received on 20 November, 1978 The editor of the European journal could, however, recall the processing of the paper the article was received at their Brussels office on 10 October 1978 and thereafter sent to two referees in the US One did not reply, it was later found out that he had died The second okayed the paper The editor was absolutely sure no one would get hold of such material from his office The authors, too, are sure no leakage could occur at their end

Another instance of piracy soon came to light This time the pirate called himself A K K Alsabti and published a review paper in the *Journal of Cancer Research and Clinical Oncology* which, it appears was substantially lifted from Professor E F Wheelcock's grant proposal forwarded to the US Public Health Service The same article also appeared in the Czech journal *Neoplasma* Wheelcock, of the Jefferson Medical Center, Philadelphia, said that Alsabti had worked with him for five months but was asked to leave

From here Alsabti went to Texas and offered his services free at the Anderson Medical Center from where he was fired seven months later However the mystery clears up a bit at this juncture Alsabti had worked here towards the end of 1978 and it was here that Dr J A Gottlieb, the second referee (who had not replied to the European journal), had worked Gottlieb had died before Alsabti made the scene Where is Alsabti now? No one knows Pity any other medical researcher of the same name Just imagine how much trouble he would have getting his paper accepted and also how wary editors will be

RED DYE REPELS ANTS

The dye known as cochineal is secreted by small scale insects *Dactylopus confuscus* The dye has been used by man for more than a century but the question is of what use is it to the insect? Since it is chemically related to predator-repelling chemicals of other insects, T Eisner of Cornell University USA, tested it on a group of predatory ants Eisner and colleagues offered a solution of pure sucrose and a solution of sucrose and carminic acid, as this dye is chemically known, to the ants The ants flocked to the pure sucrose solution Similarly, when offered extracts of mealworm and extracts of the scale insect the ants refused the scale insect To make sure it was not colour that deterred the predator, they carried out the experiment in darkness illuminated for brief intervals by red light The results were the same

However, the dye does not protect the insect from the attack of caterpillars of the moth *Laetulia coccidivora*. This caterpillar not only devours the insect

but also makes use of the dye's repelling action by regurgitating it on its attackers

MAGNETS IN MAN?

Magnetic tissues have been found in several organisms—bacteria, bees and birds Now scientists from the California Institute of Technology, David Presti and John D Pettigrew, have found patches of magnetic material in the necks of homing pigeons Earlier reports had said that the magnetic material was dispersed all over the skull

Using glass knives to prevent contamination, Pettigrew and Presti found the black substance embedded in the tissue surrounding the fascia of the complexus muscle of tame and feral pigeons and migratory white crowned sparrows From its colour and the magnetic remanence it exhibits they think the substance is magnetite (Fe_3O_4)

This result lends support to the theory that magnetism and geomagnetism help birds to orient themselves while migrating, that is they find their way home using this magnet as a compass

Presti and Pettigrew suggest that man is also sensitive to magnetic fields One example they give is dowsing Probably the dowser's rod may be the magnification of the minute movements of the dowser's muscles in response to changes in the geomagnetic field caused by the presence of water

NEW DRUG FOR DYSTROPHY?

Although dogged by controversy there is some hope for men who suffer from muscular dystrophy The only researcher in Britain testing a new drug for the crippling disease is Dr W H S Thomson of Glasgow The drug is known as allopurinol and Thomson claims it alleviates the symptoms of the commonest form of the disease Duchenne muscular dystrophy (DMD) which is genetic and affects only boys their mothers being the carriers

The drug allopurinol works like this It blocks the breakdown of chemicals called purines in the body One important purine is adenine triphosphate (ATP), because it is the main energy source for the body enabling the muscles to contract, etc It is known that the muscles of boys who suffer from muscular dystrophy contain only about 40 per cent of the ATP seen in normal, healthy muscles

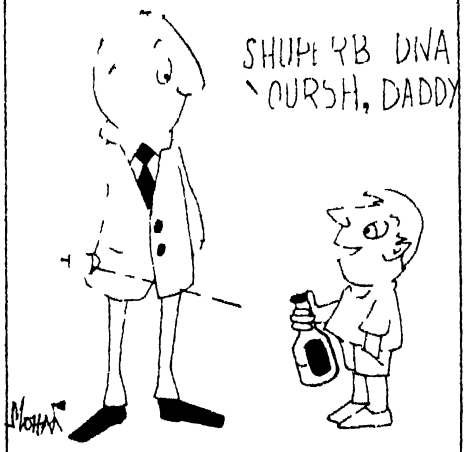
In dystrophic patients, the muscles gradually waste away According to Thomson, this wasting away is due to the short supply of ATP because all the available ATP is used up for muscle contractions, leaving little or none for the equally important functions of repair and growth So, what allopurinol actually does is to make available more ATP by decelerating the breakdown of ATP in the body.

Thomson's view of ATP function is unlike the traditional view which maintains that the membrane surrounding the muscular cells in dystrophic patients are defective, allowing ATP to leak out In other words, Thomson's theory considers ATP deficiency a cause, unlike the classical view that considers ATP deficiency a symptom, of muscular dystrophy

Thomson had tested allopurinol on eight boys suffering from DMD two years ago and found improvements in seven of them However, Thomson's critics—many of them who maintain that muscular dystrophy is incurable think only tests on a greater number of patients would bring about a statistically valid result

As a result, Thomson's paper reporting his tests were rejected by five British scientific journals Finally it was published in *Metabolism* a respected American journal Since then some other researchers testing allopurinol have found that it produced *no* results Recently, Thomson's work faced a lot of criticism and the Muscular Dystrophy Group in Britain a charity, stopped the funds they had been giving Thomson for his work

However, others feel it is too early to do away with allopurinol Thus the French counterpart of the Muscular Dystrophy Group, the Union des Myopathes has agreed to help Thomson with funds



ALCOHOLISM IS IN THE BLOOD

It looks like alcoholism is genetic! Researchers at the University of Washington, Seattle USA, had earlier found that the children or siblings of alcoholics tend to be more inclined to alcohol than others

Now, a study group from the University of Iowa reports evidence for this They report that children of alcoholic parents who happened to be adopted by non-alcoholic parents tend to be more prone to alcoholism than do adoptees of non-alcoholic parents That means, the genetic factor is important Further, the group found that "none of the environmental factors—psychiatric or alcohol problems in the adoptive family or exposure to discontinuous mothering as an infant—predicted adoptee alcoholism"

Remi J Cadoret, leader of the Iowa group, became interested in the subject of genetic alcoholism after he observed that a history of antisocial behaviour on the part of the biological parents was a statistical predictor of a child's antisocial behaviour, but not of a youngster's alcoholic tendency, an alcoholic parent predicted an alcoholic offspring, but not necessarily an antisocial one

BUTTERFLY BUSINESS

The dainty wings of butterflies have given a lift to the national economy of Papua, New Guinea People from more than 500 villages are in the business of butterfly farming Millions of insects are caught and sold to entomologists, museums, private collectors and most of all to ordinary people The wings are mounted in plastic and used to decorate ornamental objects

The butterfly trade is helping the welfare of many villages The insect money allows people to participate in cash economy without upsetting village life

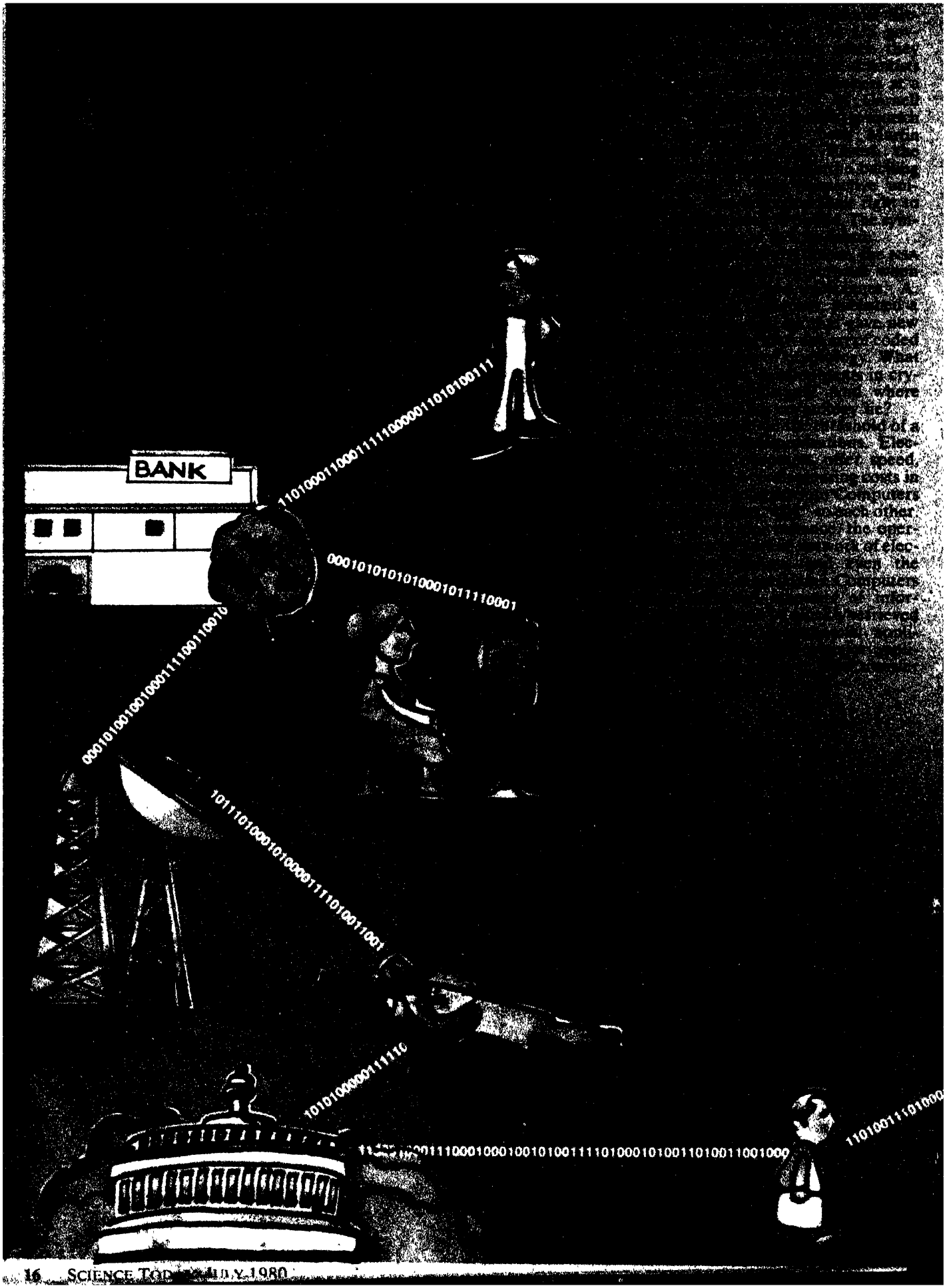
All that they have to do to raise butterflies is to plant circlets of flowering shrubs on which particular insects feed Inside the circlets are planted leafy bushes for caterpillars to feed on This maintains a breeding population Once the farm is established the farmer never has to look for new specimens since wild butterflies are very prolific

The government of Papua helps the farmers by providing guidance and material The materials include syringes and ethyl acetate to kill specimens and wax paper to wrap them About half the pupae in the farm are destined to die They are gathered and hung in mosquito nets and killed as soon as the adult emerges

This new method of farming also holds out hope for conserving endangered species all over the world This should be possible once researchers identify which plant the rare species thrive on

MISHA FROM SPACE

Some favoured guests at the Moscow Olympics will probably go home with space-born Misha The cute little mascot of the 1980 Olympics is to be fabricated in space Using polyurethane, Soviet scientists will press out the bear models in the Salyut 6 space-station This will provide the scientists an opportunity to see how plastic behaves in zero g, the findings will also be of use to set fractures in case of any accident aboard space stations


BANK
1101000110001111100001101010011
0001010101010001011110001
0001010010010001111001110010
1011101000101000011110100110011
1010100000111110
1101001110100



...end of World War II — in which cryptology played a very decisive role — has been documented in great detail in David Kahn's *The Codebreakers*, 1968. References to cryptology appear in Kautilya's *Artha Sastra*, the classical Indian work on statecraft. Even the *Kama Sutra* lists secret writing as one of the 64 arts that women should know and practise!

Cryptology today is no longer the preserve of the military and diplomatic communities. Its increasing importance for civilian and commercial purposes today is remarkable. This has called for new approaches in the science, because conventional cryptosystems are woefully inadequate when the volume of messages is large — just as electronic mail becomes an almost total substitute for conventional paper mail.

To understand the significance of the breakthrough in cryptology made in the last few years, let us briefly review the basic principles of classical cryptology. The encryption process here consists of two parts: a *key* according to which the original message is altered and a *procedure* (an *algorithm* in modern computer language) describing how the message is altered. In the Caesar cipher (attributed to Julius Caesar) the key is a number — 3, for example — and the procedure is to substitute each letter of the text by the next *third* letter in the string A B C D...X Y Z arranged in cyclic order. For example A is replaced by D, B by E, ...X by A, Y by B and Z by C. So a message from Caesar to one of his generals, COME SOON, would be encrypted as FRPH VRRQ.

It is usually presumed that the ... cryptanalyst is aware of the ... and has only to discover ... key. The Caesar cipher is obvi... very easy to break; it is a simple ... trivial example of what is ... a substitution cipher. A ... commonly used substitution ... for the secret key, a ran... ... of the alphabets, for ..., THQANZKPOSVCF ... YOBJRMWD, which is ... to the receiver in ... The procedure is to sub... ... the message, A by T, B by H, ... Z by G. Thus COME SOON ... becomes OIRSYIIE. The receiver ... the encryption process by sub... A for T, B for H... etc. Since ... are 26 factorial (26 x 25 x 24 ... x 1, or approximately 4×10^{26}) ... keys of this type, it would ... that the cryptanalyst's task is ... difficult.

In reality it is not so, except when the message is a very short one. A powerful tool available to the cryptanalyst is the information on the relative frequencies of occurrence of

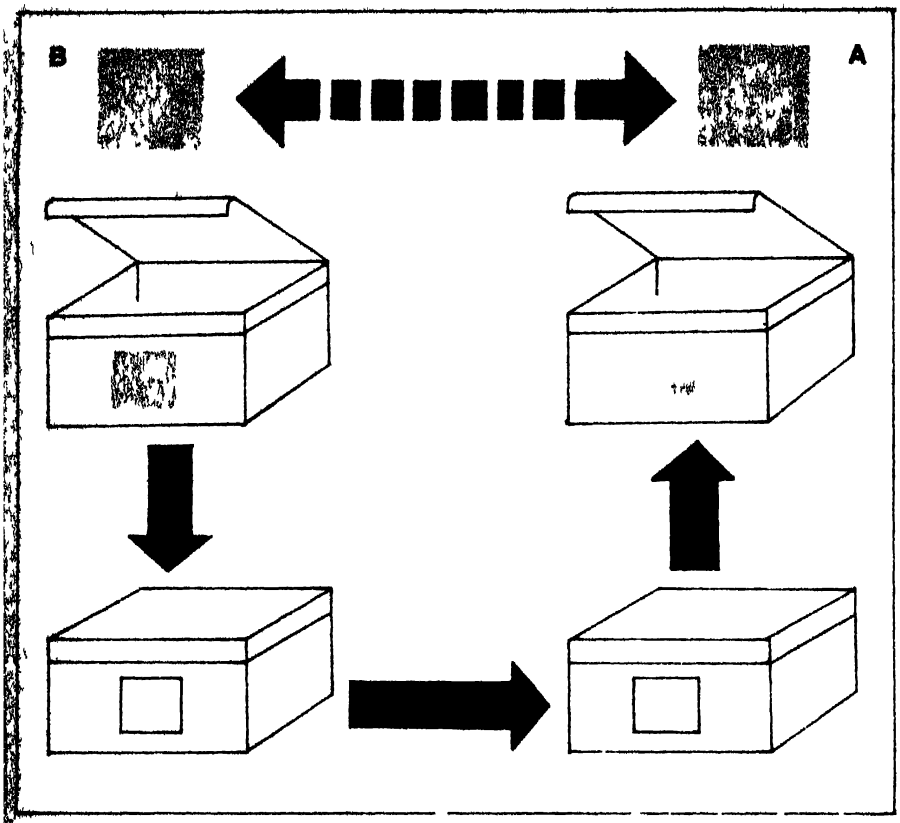


Fig 1 In the conventional cryptosystem two persons A and B share the same key which is like a resettable combination lock A and B agree on a particular combination (*indicated in grey*) through a private courier (*discontinuous double-headed arrow*) The system is like a mathematical strongbox which can be opened using the combination On the left B opens the box by setting the combination puts in the message closes the box and scrambles the combination lock The box is now sent to A through a public channel (*solid arrow*) On the right receiver A resets the combination and opens the box An eavesdropper or forger if he intercepts the box en route cannot read or tamper with the message since he does not know the combination

alphabets in the language In English, for example, the alphabets ranked in order of their frequencies of occurrence is E T O A N I R S L C M D H U P F G W Y B U K Q X Z J, with E accounting for nearly 12 per cent of all the alphabets, T for 10 per cent, etc (The letter J occurs only once in about 4,000 letters) Similar frequency tables are compiled for digraphs (pairs of letters) such as *th, er, on, an, re, he, in, ed, nd* etc and trigraphs *the, and, tha, ent, ani*, etc Another useful statistics is that the ten words, *the, of, and, to, a, in, that, it, is*, and *I* account for nearly 27 per cent of all words used It is a remarkable property of all languages that the frequencies are not dependent on the style or content of the text In *The Adventure of Dancing Men*, Sherlock Holmes cleverly decodes mysterious messages by this technique The method works since, in a substitution cipher, the letter frequencies are unchanged—only the letters carry different labels For example, the most commonly occurring letter in the cipher-text is likely to be the substitution for E and so on This illustrates the fact that mere statistical arguments and so-called proofs of impossibility of code-breaking have often proved to be unreliable Modern computers, with their prodigious speeds, have proved to be powerful tools for cryptanalysts

The one-time pad

There has been for centuries the quest for an unbreakable cipher, and for the last 50 years there has in fact been in use an unbreakable code Called the 'one-time pad (OTP), it is the only mathematically proven unbreakable code Surprisingly, it is a modified version of the old Caesar cipher In the OTP, the key number is changed for every alphabet substitution For example, using the key string 3 1 2 9 7 0 2 8, the message COME SOON will be encrypted as FPON ZOQV Clearly, the superiority of this method is due to the fact that the relative letter frequencies are also randomly altered The OTP is so called because each of these random strings printed on pads was torn off and destroyed after single use Proof of security of the OTP is based on Claude Shannon's information theory', a mathematical theory of communication developed in the early 1940s Shannon worked on cryptanalytic techniques during World War II and modern versions of conventional cryptosystems are essentially based on his work. In fact Shannon showed that, though there are about 4×10^{20} possible keys in the simple substitution scheme mentioned earlier, it requires no more than a message of the order of 26 letters for a cryptanalyst to discover the key It is easy to see why the one time pad is unbreakable Given a cipher-text of some length, *every* possible message of the *same* length is a legitimate message Further, once the plain-text contained in a coded message is found, it is of no future help to the cryptanalyst since the next time the key will be different The one-time pad, of course, requires prior exchange by private courier of the secret key, which being as long as the message, poses great problems of key distribution in modern communications of large volume Yet, the OTP is still the most widely used method in secret military and diplomatic communications Two persons who want to exchange messages carry a copy each of a codebook —nothing but a string of random numbers—each string being used only once In the modern version, the OTP can be a small cassette tape with a random string of 0s and 1s The hotline between the White House and the Kremlin is believed to use such a one-time system

The major difficulties with the one-time pad are its key length and the methods of key exchange for large volumes of messages The new revolution in cryptography promises to solve these problems in a most ingenious manner

Public-key cryptosystems

Great advances in cryptology began when it was realised that powerful mathematical techniques can be used in designing cryptosystems In the last three years, some young university computer scientists have pioneered new notions—again of mathematical nature—which are of far-reaching consequences, especially for civilian and commercial cryptosystems These are known as *public*-key cryptosystems to distinguish them from the conventional *private*-key systems and are based on the mathematical concept of one-way trap-door functions

In the conventional schemes, the encrypting and decrypting keys are the same and therefore the encrypting key cannot be made public (Fig 1). However, if the encrypting key E and decrypting key D are different, and D cannot be computed easily even with the knowledge of E, then E may be publicly revealed It should, however, be possible to compute the

keys E and D easily, though computing one from the other is almost impossible even with the most powerful computer. Before encryption, the message is first converted into a string of numbers (M) according to some standard code (see box below). Encryption alters the number representing the message into another called the cipher (C) and decryption recovers the message M from C. E and D can be regarded therefore as pairs of mathematical functions, D being the inverse of E, since the operation D reverses the encryption made by E and recovers the message. If D cannot be easily computed from E, we have a *one-way* function. One-way functions are used extensively today in time-sharing computer networks to verify the bonafides of users.

However, if the function E has the property that D can be computed easily, provided some additional information (usually kept secret in the cryptologic sense) is available, then it is known as a *one-way trap-door* function. The trap-door analogy is very apt—because one can easily pass through a trap-door but cannot escape unless he knows the location of the secret "opening" button inside. Further, for practical use, the functions E and D themselves should be simple enough so that encryption and decryption can be done speedily.

The above conceptual scheme was proposed by Whitfield Diffie and Martin Hellman, two Stanford University computer scientists in their seminal paper "New Directions in Cryptography". It has four major ingredients, summarised below:

Each user of the public-key cryptosystem has own pair of encryption (E) and decryption (D) keys. E is made public (say in a directory) but D is kept secret. The message is converted into a string of numbers (M).

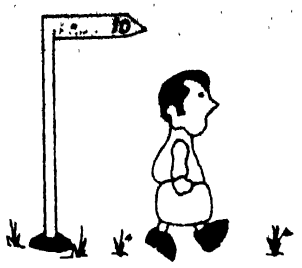
I. Decrypting an encrypted message M yields M. (Mathematically, encryption can be written as E (M) = C, and decryption as D (C) = M. C is the cipher-text transmitted to the receiver. Note, both the encryption and decryption *procedures* themselves are assumed to be public knowledge, only the key is secret.)

II. Both encryption and decryption are easy computations.

III. By publicly revealing the key E, the user does not reveal an easy way to compute the key D. So, only the user can decrypt messages encrypted with E, and

IV. If a message is *decrypted first* and then encrypted, the message is again recovered (mathematically, if D (M) = S, then E (S) = (M).

The first three points essentially define the one-way trap-door function. The addition of IV makes it a one-way trap-door permutation. The reader who wonders why anyone would want to decrypt a plain-text message will see later why it is done.



Let us examine how the scheme works in practice. Suppose two persons A and B want to exchange secret messages. Each has his own distinct E and D keys (say E_A, D_A and E_B, D_B). The E keys are revealed publicly. But the D keys are held secret. If B wants to send a message M to A, he encrypts it with A's publicly known key E_A and sends the transformed message (cipher) over a public communication channel (possibly telephone or telegraphic links) to A (Figs. 2a and 2b). On receiving the cipher, A will decrypt it with his secret key D_A and recover the message (guranteed by I). An unauthorised person, X, cannot decrypt the cipher because he does not know D_A and cannot compute it easily from the publicly revealed E_A (guaranteed by III). A can respond to B's message in a like manner.

Note that the encrypted message is sent on a public channel and no prior exchange of any secret key is involved. (Of course, an intruder can perhaps prevent A from receiving the message, but he cannot read it himself.) Fig. 3 describes how this results in great economy in the number of keys required when a large group of people is involved. The number of public keys E is no more than the number of users, but a secret communication is possible between *every* pair of users. For example, if there are 100 users, there are 100 x 99/2 or 4,950 different pairs of users and in a conventional cryptosystem 4,950 different keys will be needed. By bringing down the key requirement to one per user (not one for every pair of users), the system becomes similar to a telephone system (where each user has just one telephone number) with, of course, the additional advantage of strict privacy in communication (no wire-tapping is possible). This great economy in the number of keys is achieved by decoupling the encrypting and decrypting keys.

Signature

In the above example, how can A be assured that the message indeed came from B? Any outsider, X, could have sent the message claiming it is from B, since the encrypting key E_A is public. Thus, while the above scheme provides privacy, it appar-

Numerical encoding of the alphabet

MODERN cryptography uses mathematical transformations for encrypting and decrypting secret messages. The plain text is therefore converted into a string of numbers before encryption. The substitutions can be done with the familiar decimal numbers *(column 2)* or binary numbers *(column 3)*, which is the language of digital computers. In the binary system, only numerals 0 and 1 are used and the place values are powers of 2, instead of powers of 10. For example, $19 = 10 \times 1 + 9$, and the corresponding binary representation (10011) is $2^4 \times 1 + 2^3 \times 0 + 2^2 \times 0 + 2^1 \times 1 + 2^0 \times 1 = 19$. Every decimal number has a binary equivalent. Numbers and punctuation marks such as a full stop (as also space or blank) can also be assigned codes. In a decimal code with two digits, 100 assignments are possible. Some of these may not be needed. In a binary code with five digits, 32 assignments are possible. The RSA (Rivest-Shamir-Adleman) scheme uses decimal coding, while the MH (Merkle-Hellman) scheme uses the binary. The numerical coding is by itself a universally known standard procedure, and not part of cryptology.

Alphabet	Decimal code	Binary code
A	01	00001
B	02	00010
C	03	00011
D	04	00100
E	05	00101
F	06	00110
G	07	00111
H	08	01000
I	09	01001
J	10	01010
K	11	01011
L	12	01100
M	13	01101
N	14	01110
O	15	01111
P	16	10000
Q	17	10001
R	18	10010
S	19	10011
T	20	10100
U	21	10101
V	22	10110
W	23	10111
X	24	11000
Y	25	11001
Z	26	11010
Space	00	00000
Full stop	27	11011

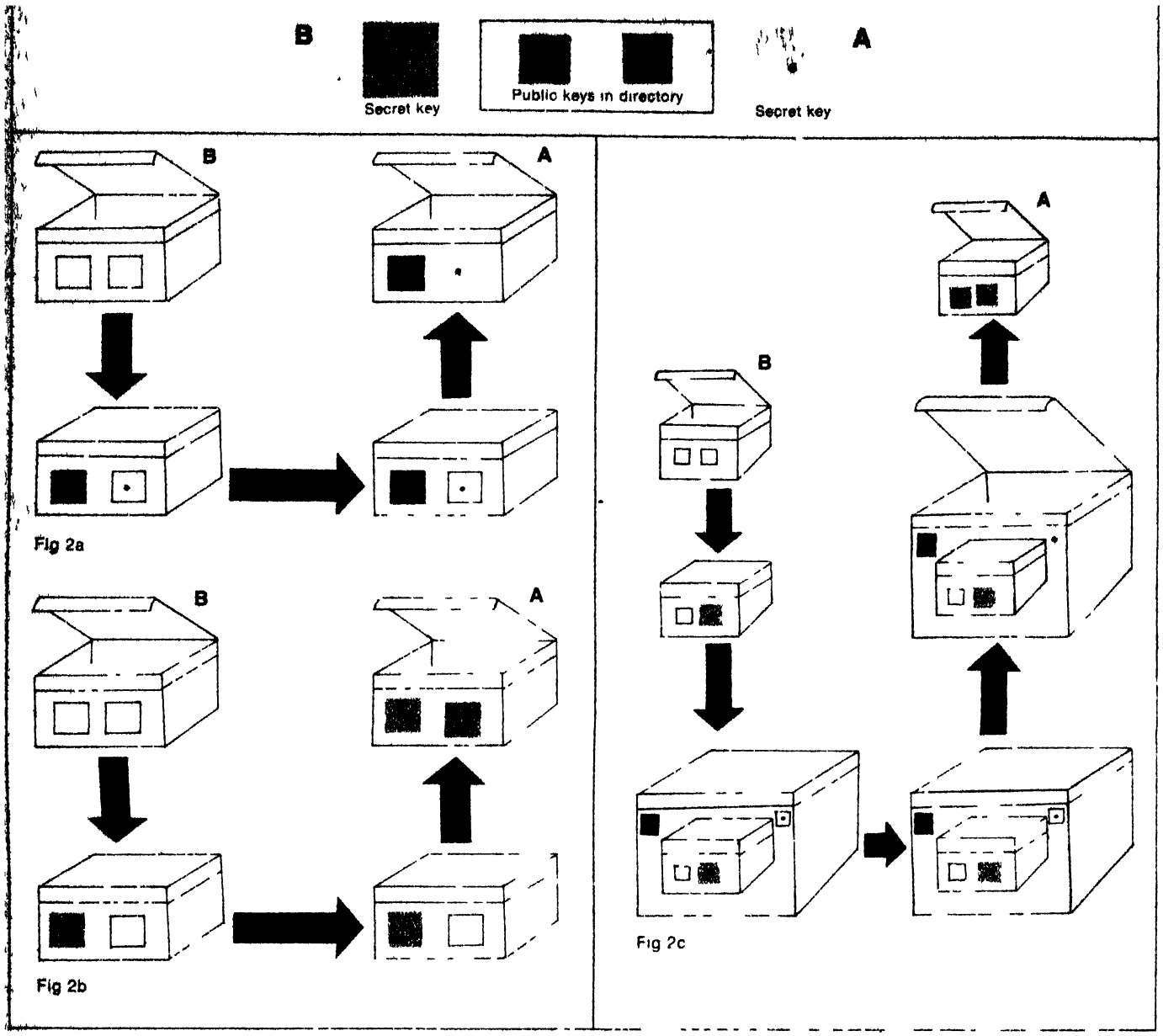


Fig 2a. In the public-key cryptosystem, the mathematical strongbox can be thought of as having two separate locks, one for locking and another for unlocking, and each having its own combination. The two combinations are mathematical inverses in the sense that one combination undoes the other and opens the box Every user has his own pair of locking and unlocking combinations which he chooses *(indicated by green and red respectively for B, and blue and yellow respectively for A)* The locking combinations are public *(shown in the centre within squares)* whereas the unlocking combinations *(shown within dotted squares)* are held secret by each person to himself *(shown on the left for B as red, and on the right for A as yellow)* In the top left, B places a secret message in the box, closes it, sets the locking combination *(blue)* and sends the box to A by a public channel *(solid arrow)* On the right, A sets his secretly held unlocking combination *(yellow)* and opens the box An intruder, even if he intercepts the box, cannot open it because he cannot determine the unlocking combination *(yellow)* from the publicly revealed locking combination *(blue)*

Fig 2b An alternative method is for B *(on the left)* to put the message in the box, set his secret combination *(shown as red in dotted square)* and send the box to A *(solid arrow)* On the right, A sets the publicly known combination *(green)* and opens the box This method uses the *sender's* combination whereas the previous method used the *receiver's* combination This is possible because the order of [illegible] the locking and unlocking combinations can be interchanged

Fig 2c Sending a *signed* secret message involves use of the locking and unlocking combinations of both the sender and the receiver On the left, B 'signs his messages to A by first putting it in a strongbox and setting *his own* secret combination *(red in dotted square)* He then puts the box in a second box and sets the *public* combination *(blue)* of the receiver On the right, when this box is received by A through a public channel, A first opens the second box by setting his secret combination *(yellow)* He removes the first box from the second box and opens it by setting B s public combination *(green)* In this case, A is assured that the first box could have been sent only by B since he alone could have set the red combination So, in effect, the message has B s signature If any outsider X had sent the message setting his secret combination *(not red)*, the box could not be opened with a green combination For the same reason, the message could not be altered and put back in the box Therefore, the message is unalterable— not even by A Also, B cannot deny having sent the message because, if necessary, A can prove to a judge that the message came from B To do this, he opens both the boxes in the presence of a judge Prior to this, A could not have tampered with the message because he could not have closed the box with the red combination which is known only to B In a real situation where messages are encrypted and decrypted, at every step illustrated above, there is an output from a computer The sequence of such outputs can serve as proof of B having sent the message and no physical presence of the message before a judge is required

only lacks a means of authentication. But one of the most interesting features of the Diffie-Hellman scheme is that it is possible to send *signed* messages in privacy (Fig. 2c). The devilishly ingenious trick works as follows. When B wants to send a signed message M to A, he first *decrypts* it with his own secret key D_B as though the message were a cipher he has received. He then encrypts the result (S) with A's public key E_A and sends the resulting cipher C to A. This is a two-step process. When A receives the message he has to decrypt again in two steps: first with his own secret key D_A (which gives S) and then again with B's public key E_B which recovers the message. (This requires that A know in advance that the cipher comes from B. There are many ways of doing this. For example, the signed message can be preceded by another message—unsigned but private—giving the name and the key E of the sender of the cipher which will follow.)

This message could have come only from B, since the doubly-encoded cipher involved B's secret key. This also makes the message forgery-proof, even if A wants to do any forging.

When two persons A and B exchange messages they need protection not only from an outside eavesdropper or forger, but also from each other (banker and customer or between two competing companies). For example, when B has sent a message to A, and A wants assurance that B cannot later deny having sent it, or when B wants assurance that A cannot alter his message, the double-encoding scheme helps. If necessary, A can prove to a third party (say a judge) that the message indeed came from B. A's proof will simply be the intermediate result S (for signature) in his two-step decoding. A cannot produce another S, corresponding to an altered message, since he does not know B's secret key. Therefore, public-key cryptosystems based on one-way trap-door functions solve not only the problem of key distribution, but also provide a digital signature—something not possible in conventional cryptology. (When a single key is shared between a sender and a receiver, there is nothing to prevent the receiver from sending himself, messages that appear to come from the sender!)

In the double-encoding scheme, the signature is not an appendage to the message as in conventional correspondence, but depends on the message; it is as though the message is hand-written with the hand-writing itself providing the signature. In an electronic signature scheme this is necessary, since otherwise any signature can be attached to any message: for instance, A can copy B's signature and attach it to some other message (electronic "cutting" and "pasting"). However, to be able to sign a message one has to have his own keys E and D and therefore be a member of an inter-communication network. Note that anyone, even from outside the network, can *send* unsigned but private messages to any member of the network.

The Rivest-Shamir-Adleman scheme

The Diffie-Hellman scheme just described is only conceptual. How does one implement it in practice? In other words, are there in real life, one-way trap-door permuting functions that satisfy the four criteria of Diffie and Hellman? In April 1977, within a few months of Diffie and Hellman's publication of the concept, Rivest, Shamir and Adleman, three computer scientists from Massachusetts Institute of Technology, Cambridge, USA, in a remarkable tour-de-force described in great detail a practical scheme which meets all the requirements of a public-key cryptosystem to near perfection. Surprisingly the scheme is based on some theorems in number theory, very well known for more than 200 years, attributed to Fermat (1601-1665) and Euler (1707-1783). Number theory

Factorising large numbers

THE SECURITY of the RSA scheme depends on the near impossibility of finding the factors of very large numbers. This is not due to lack of effort, because factorisation has been a well-known problem for nearly 300 years—some of the more efficient algorithms today are based on the classic works of Fermat and Legendre.

The naivest approach to factorisation of a number N is to divide N successively by *all primes* less than or equal to the square root of N, and test if the remainder is zero. (It is enough to restrict the divisibility test to prime numbers below $\sqrt{N}$ because if N does have a factor greater than $\sqrt{N}$, it should have at least one other factor less than $N/\sqrt{N} = \sqrt{N}$, and this factor would have already been discovered in the trials upto $\sqrt{N}$.) Now, cleverly designed algorithms have reduced the task to a number of trials proportional to the fourth root of N. However, the fastest known algorithm for factorising large numbers is attributed to Schroeppel (unpublished). It requires $e^{\sqrt{\ln N \ln \ln N}}$ operations, where e is a constant (=2.718), and ln N, the natural logarithm of N.

The table (below) gives the number of operations required for factorising numbers of different sizes. The computation times given are for a current state-of-the-art computer capable of about a million operations per second. Rivest, Shamir and Adleman recommend using a 200-digit number for N, because the factorisation time of 3.8 billion years provides adequate safeguard, even if one takes into account the rapid development of computer technology.

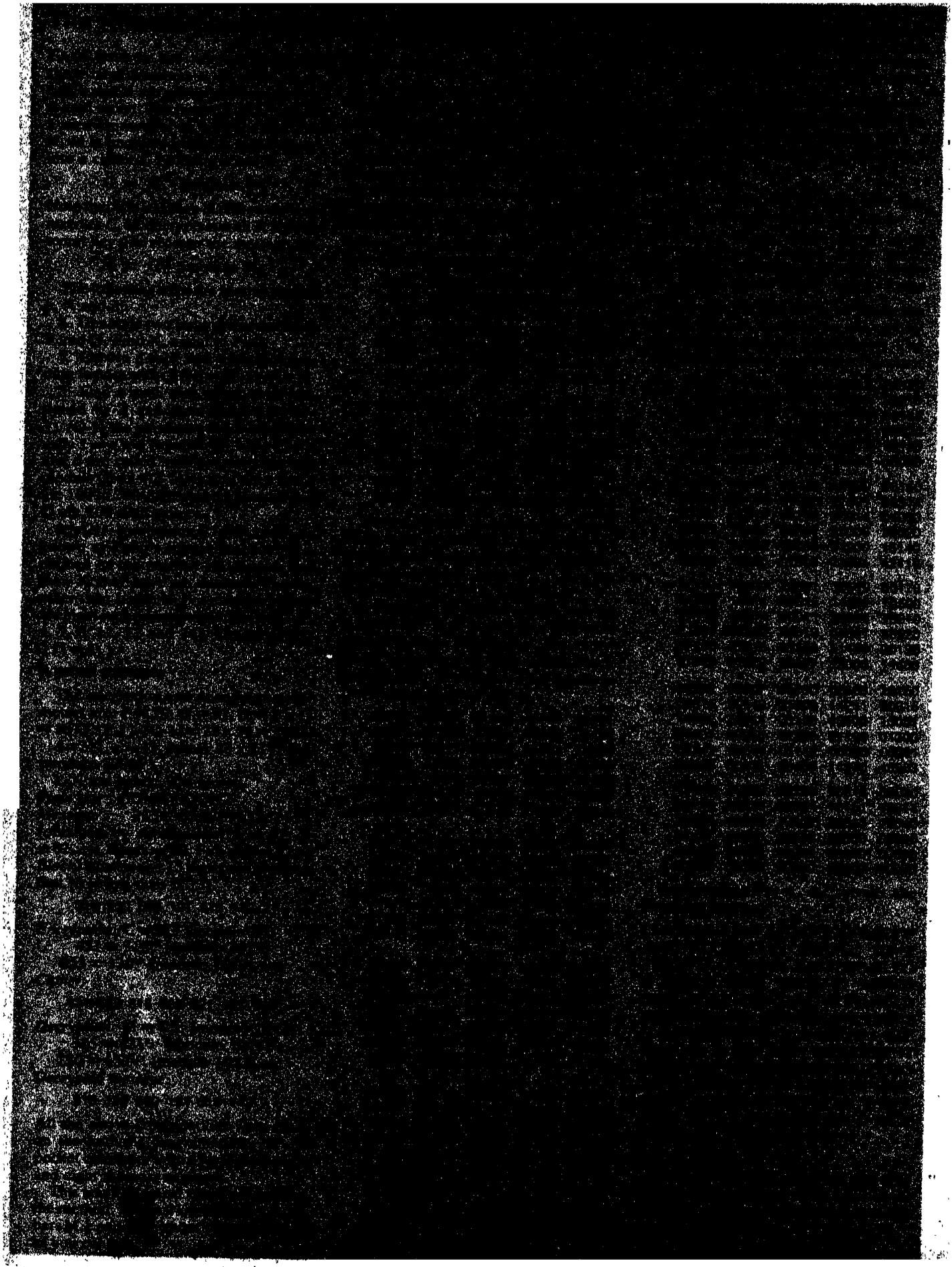
But can sheer computing power ever beat the RSA scheme? The answer is no, because there are certain fundamental limitations to computing power (even by or large numbers). It is an easy task to increase the size of N and make the computation practically impossible.

An increase of N from 200 to 300 digits increases the effort of encryption and decryption (for the order of a few seconds) only by about 50 per cent, whereas the time needed for the factorisation of N increases nearly billion-fold. The RSA algorithm permits a choice of N appropriate to the required degree of security against cryptanalysis.

Only a faster algorithm for factorisation, with the number of operations increasing as some power of the number of digits in N, can compromise the scheme. *If the RSA scheme is broken, it will not be through technology, but by pure mathematics.* Because of the enormous importance of this problem for cryptology, research in factorisation is perhaps already classified as top secret by some organisations. The National Security Agency, the top code-making and code-breaking organisation under the US government, convened a secret conference of top mathematicians in the summer of 1978 to explore factorisation algorithms.

Digits in N	Number of operations	Time
	1.4×10^{12}	5.9 hours
	5.0×10^{13}	164 days
	6.3×10^{15}	74 years
	2.8×10^{17}	2.4×10^{3} years
	1.3×10^{19}	3.8×10^{4} years
	1.0×10^{20}	4.9×10^{5} years
	2.8×10^{21}	6.2×10^{6} years

[illegible] would have taken 610 million years to [illegible] key).



deals with the properties of the natural numbers 1, 2, 3... and is generally considered to be the purest form of mathematics with no prospects of any practical applications, an opinion usually attributed to the famous British mathematician G. H. Hardy who, incidentally, 'discovered' Ramanujan.

A fundamental concept in number theory is the prime number. Any number that cannot be divided exactly by any number other than 1 and the number itself is called a prime number (example 7, 29, etc). All the other numbers are said to be composite. For example 21 is composite since it is divided exactly by 3 and 7, which are known as its factors. While it is easy to find the factors of small numbers, the task becomes extremely difficult even for the fastest computers if the number is very large (exceeding, say, 100 digits). But it is not necessary to find the factors of a number to decide whether it is composite or prime. There are fast computer algorithms which can test if a given number is prime or not and to generate large prime numbers at random.

The Rivest-Shamir-Adleman (RSA) algorithm for encryption and decryption exploits the fact that while it is easy to generate large primes, it is almost impossible to factorise a large composite number into its prime factors. Specifically, a prime number of 100 digits can be generated in a few minutes on a common PDP-10 computer. Two such large prime numbers P and Q (each 100 digits long) can be easily multiplied to produce a composite number N of 200 digits. But given N, to find its factors P and Q (assuming of course they are held secret), even the fastest available computer with the fastest known algorithm (see box, p. 21) will take about four billion years, which happens to be approximately the age of our solar system! Hereafter, let us refer to the person who wishes to receive messages as the user of the cryptosystem. Each user generates two large prime numbers P and Q as mentioned above and also two other large numbers d and e which depend upon P and Q. P and Q are multiplied together to obtain N. For encrypting, a sender of messages needs both e (for encryption) and N. Therefore, these two numbers are made public (say in a directory) by the user. He however keeps d (for decryption) secret and uses both d and N for decrypting an encrypted message received by him.

What are the encrypting and decrypting procedures? First, a sender (let's call him John) of the message looks up the directory to find the numbers e and N of the user (say, Mary). He then converts his message text into a number M, by suitable substitution of the alphabets and punctuation marks by numbers (A = 01, B = 02 ... Z = 26 etc) It is necessary that M should be less than N. (If necessary, a long message can be broken into blocks and each block encrypted separately.) After that M is raised to the power e (that is, M is multiplied by itself e-1 times), the result divided by N, the quotient discarded and the remainder C is computed. C is the cipher which is transmitted to Mary on a public channel.

Mathematically this encryption is written as

$$C = M^e \text{ (modulo N)}$$

(Note that C is a number less than N since it is obtained as a remainder after division by N.)

On receiving C, Mary decrypts it by using d, her secret key, and N. The decryption procedure is identical to encryption but with C in place of M and d in place of e. In other words, C is raised to the power d, the result divided by N and the remainder computed. This remainder is nothing but the original number M. Mathematically speaking, decryption is

$$M = C^d \text{ (modulo N)}$$

It is one of the marvels of number theory and modular arithmetic that such a pair of numbers e and d exists. The arithmetic here is called modular arithmetic. Here, every number, however big, is reduced to a number less than a number N (called the modulus) by dividing with N and taking only the remainder. The result is particularly remarkable when one considers that after computing M—a very large number—one is dividing by N and throwing away the "cake" which is the quotient and retaining only the "crumbs", the remainder. An example of modular arithmetic in every day life is the following: if you want to know the day of the week 100 days from today, you can divide 100 by 7, discard the quotient 14 and take only the remainder 2. The answer is obtained by counting two days from today. (If today is Monday, the answer is Wednesday). The notation used in modular arithmetic—for example $2 = 100$ (modulo 7)—first introduced by Gauss, is a very powerful one. It greatly simplifies proofs of problems in number theory.

The security of the system depends on the fact that d is held secret by Mary and cannot be determined by anyone from the publicly known e and N alone. To determine d, one has to find the factors (P and Q) of N, which is computationally infeasible.

The methods to determine encryption and decryption keys and the encryption and decryption procedures are given on p. 22 as also an illustration of the real situation with

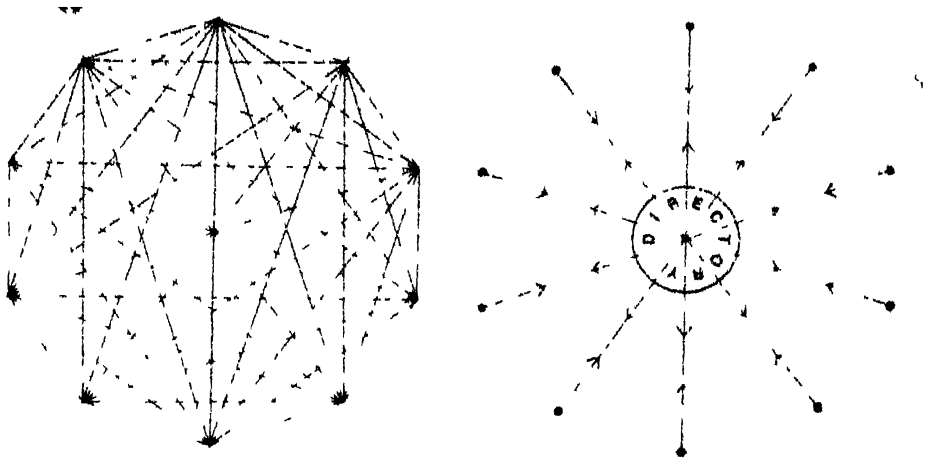


Fig 3 Consider a group of ten people *(represented by dots)* who wish to communicate among themselves in strict privacy In conventional private-key cryptosystems *(left)*, every pair among the ten will have a secret key that is shared only between them *(shown by the line joining two points)* This key has to be privately exchanged, say, through a trusted courier, before the secret communication The 45 possible pairs in a group of ten require 45 separate keys For n persons, the number of keys is n(n-1)/2 But in a public-key cryptosystem *(right)* the encrypting and decrypting keys are separate revealing the encryption key does not permit an easy way of finding the decryption key and each person need have only one public encryption key and one secret decryption key The public keys are put in a directory shown at the centre, so that any person can communicate with any other person in secrecy through the directory *(shown by arrows)* The number of keys required in this scheme is 2n (n for encryption and n for decryption) When n is very large, great economy is achieved in the number of keys The ratio of the number of keys in the two systems is (n-1)/4 which is about 250 even for n=1000 Also the same key can in principle be used indefinitely whereas in the private-key system, keys have to be changed frequently to foil any attempt by cryptanalysts to find the key

large numbers.

There are numerous details to be considered in a practical implementation of this RSA scheme. The interested reader is referred to the original paper for such details. Perhaps the ultimate application of the scheme will be the encryption and decryption of *voice* signals over a telephone line in *real time* which enables two persons to talk to each other without fear of eavesdropping or wire-tapping by unauthorised persons.

Rivest, Shamir and Adleman are quick to point out that the security of their scheme needs to be examined carefully and, in particular, the problem of factorising large numbers. The only certification of security of the method today is the fact that so far no fast factorisation algorithm is known. Although it appears unlikely, it is possible that some breakthrough in number theory will lead to such an algorithm. In fact, it is not even proved mathematically that breaking the RSA scheme is equivalent to factorisation in computational complexity. Recently Michael O. Rabin of Hebrew University, Jerusalem, has proposed a slightly modified version of the RSA scheme in which the above equivalence has in fact been mathematically proved. Rabin's proof is considered a major theoretical advance towards the goal of developing provably secure cryptosystems.

The trap-door knapsack: Merkle-Hellman scheme

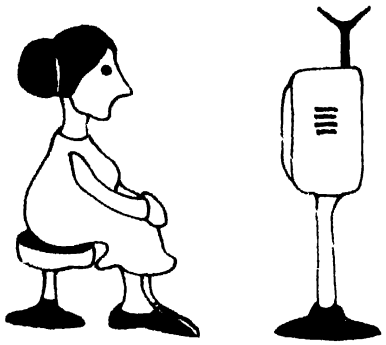
Ralph Merkle and Martin Hellman have proposed another scheme for a public-key cryptosystem based on a very well-known problem in operational research called the "Knapsack problem". The problem (see Fig.4) can be stated very simply as follows: given a set of numbers and another number S, find which of the numbers in the set add up exactly to S?

For example, let the set contain six numbers as below:

a (8 10 12 15 16 34)

Let S=57. Which numbers of the set a will add up to 57? After some trials one finds the solution, 57 8+15+34. In general, if there are n numbers in the set a, there are 2^n possible ways of choosing a subset. This is easily seen because each number in the set can be either chosen or rejected (two possibilities) independent of the choice of other numbers. In the worst case, every one of these 2^n possible subsets has to be checked by adding the numbers in the subset and comparing the sum with S. In the above example, n=6 and we have 2^6=64 possibilities to check. If there are 100 numbers in the set there are 2^{100} or about 10^{30} possibilities, and in the worst case all have to be checked. At the rate of a million trials per second, this would take 3 x 10^{16} years! The best known algorithm will, however, require $2^{n/2}$ trials only; even that would require 30 years of computing time. So, the general knapsack problem for a large set of 100 or more numbers is computationally infeasible.

On the other hand, it is a trivial matter to choose a subset of the numbers and add them to find the sum S. It is the reverse or inverse process which is computationally infeasible. Thus, we have a one-way function. Merkle and Hellman have found an ingenious way to make the inverse computation also simple if the set of numbers in a is chosen with some hidden properties known only to the designer of the set. Such a knapsack set is called a trap-door knapsack.



In the Merkle-Hellman (MH) scheme, the encrypting key which is made public is the set a of n numbers (n being greater than 100). This set is derived from another set b of n *specially chosen* numbers and two other numbers v and m. The hidden properties of the numbers in the set are therefore contained in the set b and in the numbers v and m, all of which are held secret. In the MH prescription these numbers vary in size from 30 to 60 digits. As before, each user of the network has his own encrypting and decrypting keys.

What are the encrypting and decrypting procedures? First, the message to be sent is converted into a string of zeros and ones (see box, p. 19). Here John, the sender looks up Mary's encrypting set a in a public directory. He then divides his message string into x blocks of length n or less.

Let $a = (a_1\ a_2\ a_3 \ldots a_n)$ (key)

$x = (x_1\ x_2\ x_3 \ldots x_n)$ (message)

where $x_1\ x_2 \ldots x_n$ are either 0 or 1. The rows a and x are multiplied vertically and the sum S is computed.

$$S = a_1x_1 + a_2x_2 + \cdots + a_nx_n.$$

(Since x's are either zeroes or ones, S is nothing but a sum of the numbers in a subset of a.) S is the cipher which is transmitted to Mary.

On receiving S, Mary decrypts as follows: She first finds T from S, as T v x S (modulo m). To find $x_1\ x_2 \ldots x_n$ from T she solves the knapsack problem

$$T = b_1x_1 + b_2x_2 + \ldots + b_nx_n$$

where $b_1\ b_2 \ldots b_n$ is the set b she holds secret. The special character of b is that the above equation is easily solved. (Every number in that set b exceeds the sum of all the preceding numbers.) Once $x_1\ x_2 \ldots x_n$ are obtained, the message is again read by substitution of alphabets for the blocks of zeroes and ones (00001= A, 00010=B, 00011=C ... 11010=Z etc.)

A practical difficulty in this scheme is the large size of the keys (100 numbers of 60 digits each). Merkle and Hellman have suggested ways of reducing the storage capacity of the encrypting key. However, the major drawback of the MH scheme is that in its present form it cannot be used for signing or authenticating messages and hence suffers badly in comparison with the RSA scheme.

Signing messages involves decrypting the message first. For example, if Mary wants to send a signed message M, she has to solve the knapsack problem:

$$M = a_1x_1 + a_2x_2 + \ldots + a_nx_n$$

The snag is that the above equation has no solutions (that is, values $x_1\ x_2 \ldots x_n$) for most messages M. In other words, one cannot generate signatures for most of the messages.

Though the knapsack problem is of recent origin—unlike factorisation of large numbers which has a long and distinguished history—it is regarded today as one of the extremely hard problems, because its complexity grows exponentially with the size of the problem. As Hellman points out, while the traditional difficulty of the problem is an encouraging sign for practical implementation of public-key cryptosystems, it is not impossible that in the future some efficient algorithm may be discovered for the knapsack problem. In fact, the MH scheme differs from the general knapsack problem in that it has got a built-in trap-door.

Computational complexity

In computation, problems are classified according to the degree of complexity of their solution. Such things as exponentiation (raising a number to a power), finding the greatest common divisor of two large numbers, or generation of random prime numbers are

very easy. Their computational complexity increases only slowly with the size of the numbers involved.

In general, a problem is considered easy if its solution requires a number of operations which increases as some power (usually small) of the numerical size (n) of the problem (like n^2, n^3...). Such problems are called "polynomial" in complexity (class P) Hard problems are those in which the number of operations increases exponentially with the size of the problem (like 2^n, 3^n, for example) Such problems are called "Non-deterministic polynomial" in complexity (class NP) To see the wide gap in the cost of computation between class P and class NP problems, compare, for example the values of n^2 and 2^n for n=100 $100^2=10^4$ and $2^{100} = 10^{30}$ In computation theory, the adjective "non-deterministic" implies that with an unlimited number of computers operating in parallel, the computation takes polynomial time The class NP has also the distinctive feature that once the solution is known it is easy to check its correctness

Both factorisation of large numbers and the knapsack problem are in class NP In factorisation, once the factors are known, they are easy to verify (by simply multiplying the factors) Similarly, in the knapsack problem, a simple addition of numbers will verify the correctness of the solution As already pointed out, it is this feature of NP problems that is exploited in public-key cryptosystems

There is another special case of problems called 'NP-complete" (class NPC) These also belong to the class NP (they are a sub-class of NP) but with a remarkable property of equivalence among them, though they occur in widely different disciplines such as mathematics, operational research and economics The concept of NP-complete problems, introduced in 1972 by Stephen Cook, is of fundamental importance in complexity theory. It has been proved that if a method of solution that takes only polynomial time (that is, an "easy" solution) is found for *any one* of the NPC problems, then *every* problem in class NP (including class NPC) has also a polynomial time solution The class NPC has grown rapidly in recent times in membership and includes literally hundreds of problems—all of them of exponential complexity—and hence very difficult to solve One of the most challenging problems today is to prove or disprove that every NP problem is actually in class P (that is, classes P and NP are identical) Most experts believe that class P is not class NP, and therefore the NP-complete problems are indeed intractable.

The knapsack problem is an NP-complete problem, but factorisation is

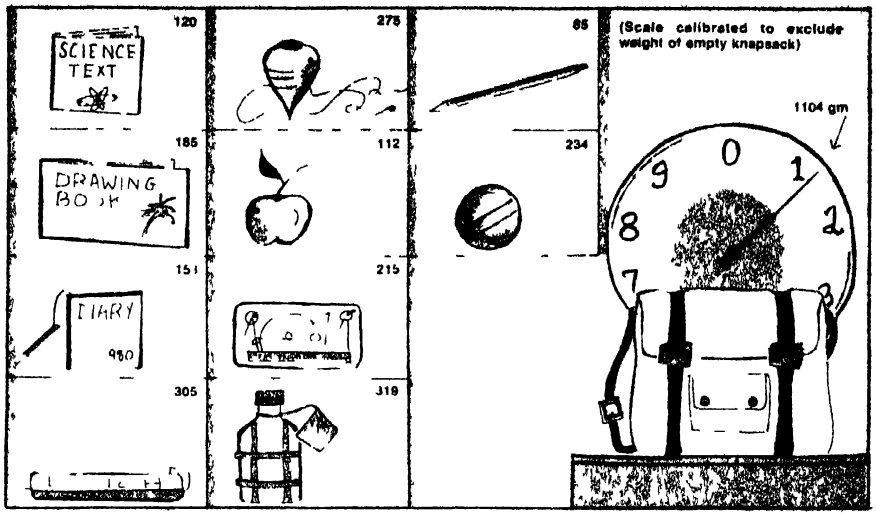


Fig 4 In the knapsack problem a set of numbers is given Given another number S, it is required to find which of the numbers in the set add up *exactly* to S For example given that the contents of the schoolboy s knapsack weigh 1104 grams which of the ten items from the list are in the knapsack? There are 2^{10} or 1024 different ways the knapsack can be filled The problem becomes almost impossible to solve when the number of items becomes very large (say 100) On the other hand given a solution it is very easy to check that it is correct by simply adding the numbers and verifying if it matches the required sum Such a problem is an example of what are called NP (non-deterministic polynomial) problems in the theory of computational complexity NP problems are encountered frequently in practice These problems are being adapted for cryptology because of their one way character which makes encryption easy but decryption difficult

only an NP-problem and is not proven to be NP-complete While this makes the knapsack problem undoubtedly a difficult one, it does not follow that factorisation is an easier problem than the knapsack problem (It is possible that it is actually even more difficult) There are four points to be noted about the difficulty in solving the knapsack problem First, complexity theory as outlined above presumes the *worst case* complexity (In other words, every possible combination of 2^n possible combinations will have to be tried to obtain a solution In reality, one may hit upon a solution mid-way, so what is relevant is only *average case* complexity) Second, the MH version of knapsack with a built-in trap-door is not proven to be NP-complete Third, because of the intractable nature of the NP-complete problems, a lot of research is afoot to find approximate solutions for them In many instances (including the knapsack problem), approximate solutions can be obtained in polynomial time For example, in the knapsack problem it may be easy to find a subset of the given numbers whose sum does not exactly match the specified sum, but differs from it only by a small and specified amount To what extent approximate solutions can be exploited in cryptoanalytic attack is still an unexplored area of research as far as public knowledge goes Finally, the knapsack problem is expressed as a linear equation with a large number of unknowns which are either 0 or 1 (that is, the unknowns appear only in first power and not in higher powers). Traditionally, linear problems are considered unsafe" for cryptographic work Recently Khachian, the young Soviet mathematician, has found a polynomial-time algorithm to solve certain special types of linear problems This is considered a great theoretical advance in computation The new method, however, is not applicable to the knapsack problem.

In comparison, the RSA scheme which exploits the difficulty of factorisation of large numbers seems to have certain advantages, though the problem is not proven to be NP-complete There can be no approximate solution to factorisation, either one finds the factors or does not. Again, encryption and decryption are not linear functions, in fact, they are highly non-linear since they involve large exponents

So far only the RSA and MH schemes appear to be serious contenders for a public-key cryptosystem The RSA scheme is the only known example of a one-way trap-door permutation (as defined by Diffie and Hellman) and therefore capable of producing digital signatures. Are there any other such mathematical functions? In principle, the NP and NP-complete problems have the potential for use as one-way trap-door functions Enormous amount of work remains to be done in this respect and it is quite possible that a scheme better than the RSA and MH schemes will be designed in the future

Problem-solving is the very basis of all science and technology Computation theory clearly points to cer-

tain unsolvable problems which will perhaps always remain unsolvable. When faced with such problems the general reaction of most scientists is to accept the inevitable. Some may show their ingenuity and obtain approximate solutions which can be of great practical use. However, in the formulation of the concept of public-key cryptosystems, we find an example of a most unconventional approach to problem-solving: the exploitation of the very weakness of computation for solving a practical problem, namely to adapt unsolvable problems for cryptology. Practical implementation of these ideas is based on number theory, considered as one of the most esoteric branches of pure mathematics—a reminder that pure research often leads to application in most unpredictable ways.

Impact of public cryptology

Soon—probably in a few years' time—cryptology will have extensive civilian and commercial applications, thanks to these new concepts. As the innovators of public cryptology themselves have pointed out, the proposed schemes are still not provably secure, though for practical purposes they appear to be so. The only certification of security they have at present is that so far no efficient method is known which can be used in cryptanalysis to break the system. For the present, therefore, most top secret communications still have to rely on the old one-time pad.

The author's emphasis here has been to outline the general principles of public-key cryptosystems and the mathematical methods on which two proposed schemes are based. Many practical problems arise in their actual implementation, but human ingenuity will in time be able to solve them. For example, how does one ensure the security of the decryption key itself? The suggestion made by Rivest is to compute it and store it in the memory for decryption and never allow it to be printed. The computer can be programmed to destroy the key if someone tries to retrieve it. A new set of key parameters (e,N,d), can very easily be produced. The RSA encryption and decryption hardware is being implemented as an IC (integrated circuit) chip for use in computers. This would further improve the speed of encryption and decryption.

These recent developments in cryptology have caused much excitement and concern in government agencies, academic circles, and even certain sections of the public. It was entirely unexpected that the concepts of public-key cryptosystems enunciated by Diffie and Hellman would be followed so soon by their practical implementation by Rivest, Shamir and Adleman. The RSA scheme got great publicity through Martin Gardner's popular column on mathematical games in the August 1977 issue of *Scientific American*.

Later, in 1978, the National Security Agency tried to prevent issue of patents based on cryptologic systems in two cases: a new scheme proposed by Prof. George DaVida of the University of Wisconsin and a cheap practical private voice communication device by a trio of freelance inventors Carl. R. Nicolai, David Miller and Carl Quale. In the first case, the NSA had to withdraw the ban it tried to impose, after protests from the University of Wisconsin.

"Public" cryptography has arrived at a time when there is a dire need for it in ensuring privacy and security in modern computer-based communications. Civilian and military interests are sometimes in conflict with each other and in future they will have to learn to co-exist. Like most revolutionary discoveries, such as nuclear fission, for example, public cryptography is a double-edged sword. It can be used for the good as well as the bad. For, illegitimate and illegal activities of spies and Mafia-type organisations can be carried on with impunity using the new secrecy systems. At the same time it can protect the private citizen from erosion of his fundamental rights by making it impossible to tap his telephone line. In recent years the ethics of such practices has been discussed widely, especially in the USA. To quote David Kahn in *The Codebreakers* "Cryptanalysis is an agression, trespass- -it is surreptitious, snooping, sneaking, it is the very opposite of all that is best in mankind. It shatters the highest ethical precept: to do unto others as we would have others do unto us... Cryptanalysis is justified only in war, for self-defence, to save lives. Otherwise it is wrong to violate another's dignity". The new revolution in cryptology, if successful, will mean the death of cryptanalysis—a prospect which is both exciting and perhaps terrifying. In the words of Martin Gardner, "All over the world there are clever men and women, some of them geniuses who have devoted their lives to the mastery of modern cryptanalysis... Now these people are standing on trap-doors that are about to spring open and drop them completely out of sight"

How large are large numbers?

IN PUBLIC-KEY cryptosystems one deals with numbers containing about 100 digits (like 10^{100}). These numbers are truly astronomical.

For example, to solve certain problems (especially in number theory) such as factorisation of very large numbers, one will require a computer with 10^{60} bits (*binary digits*) of memory, which exceeds the total number of molecules in the entire solar system! Again, 10^{70} operations (such as multiplications) on such a computer will require a minimal power (dictated by thermodynamic considerations) that would exceed the total power output of the sun!

The largest number of physical significance is perhaps 10^{125}. This is the maximum number of atoms which can be *packed* into the entire universe. The density then will be more than 10^{15} gm (or one billion tonnes) per cu cm.

Surprisingly, one encounters numbers very much larger in a mundane application, such as the transmission of voice over a telephone line. Over a 5,000-km transmission line the telephone signal undergoes an overall amplification of 10^{4000}

A round number such as 10^{100} deserves a name for itself. It is called *googol*, a name invented by Dr. Edward Kasner's nine-year old nephew *(Mathematics and Imagination by Kasner and Newman, 1966)*. He also suggested the name *googolplex* for a number which is defined as 1 followed by a googol of zeroes, that is, $10^{10^{100}}$

For RSA encryption and decryption, the message blocks M are of the order of a googol in size. So are the encryption and decryption parameters, e and d. When M is raised to the power of e we have a number of the order of

$$(10^{100})^{10^{100}}$$

which exceeds even the googolplex! However, this number is actually never be computed.

S.N.



Dr. S. Naranan is Professor of Physics at the Tata Institute of Fundamental Research, Bombay. His chief professional interests are high-energy (x-ray, gamma-ray) astrophysics and high-energy cosmic rays. He is also keenly interested in computations, bibliometrics, number theory, recreational mathematics and photography.

Recommends reading: **1.** R.L. Rivest, A. Shamir & L. Adleman "A method for obtaining digital signatures and public-key cryptosystems", *Communications ACM*, **21**, 120; **2.** R.C. Merkle & M.E. Hellman, "Hiding Information and Signatures in Trapdoor Knapsacks", *IEEE Transactions on Inf. Th.*, **24**, 525; **3.** David Kahn, *The Codebreakers;* **4.** Martin Gardner, "New Kind of Cipher...", *Scientific American*, August 1977.

Geomagnetic field and the dynamo problem

THE EXISTENCE of a magnetic field on the surface of the earth has been recognised for many centuries. William Gilbert of England in 1600 explicitly described the earth as a giant magnet. The mechanism by which this field is produced and maintained is yet not fully understood, even though it has been used for navigation, exploration of non-renewable resources, studies of the structure of man's near and far environment, etc. The problem has attracted attention of many research workers. The limiting factor in the development of a proper model has been the lack of information on physical properties of materials at the temperature and pressure prevailing in the earth's interior. However, the challenge has given stimulus to both theoretical and experimental efforts.

In general, a magnetic field can be produced in two ways—either by a permanent magnet or by the presence of electrical currents. Ferromagnetism is destroyed by heating, and the earth's interior attains such a high temperature at a depth of a few hundred kilometres that the possibility of earth being a permanent magnet of ferromagnetic material can be rejected right away. The magnitude and the geological history of the geomagnetic field imply electric currents flowing in a highly conducting fluid core as its source. It has been possible now to show that the dynamo process is the cause of the earth's main magnetic field.

The major question to be answered in the theory of geodynamo relates to the source of energy that maintains the velocity field in the fluid core. The main possibilities for the source of energy are: thermal convection generated by (a) energy released from radioactive sources in the core; (b) latent heat released in solidification of the inner core; (c) release of gravitational energy following a postulated steady decrease with time of the gravitational constant, G, and (d) due to torque produced by the sun and the moon on the core. The consensus appears to be in favour of convection generated by the heat of radioactive decay. For a variety of reasons, geochemists believe the source to be the radioactive isotope ^{40}K. The earth's age is some 4.5 billion years and it took about 1.5 billion years for the core-mantle structure to develop and stabilise. The half-life of ^{40}K is 1.3 billion years, and the heat due to its radioactive decay could provide a stable field on a long-term basis.

However, recently the presence of ^{40}K as the source of energy in the core has been refuted on many considerations. Larry Ruff and D. L. Anderson of the California Institute of Technology in a recent paper (*Physics of the Earth and Planetary Interiors* **21** 181) suggest long-lived uranium and thorium as sources of the radiogenic heat of the geodynamo. A modified inhomogeneous accretion model of the earth has been proposed by them and this "leads to an initial metallic iron and refracting enrichment at the centre of the planet. The probable heat source for the melting of the core is the decay of ^{26}Al, which is short-lived. The refractory material is emplaced irregularly in the lower mantle with uranium and thorium serving as a long-lived heat source". Our knowledge of geodynamo has considerably progressed in the last 25 years and the present paper has put forward an interesting idea about the nature of the source for driving the core dynamo. Yet, much remains to be done.

B. P. SINGH

Prof Singh is with the Indian Institute of Geomagnetism, Bombay

Did the earth have a ring?

STUDIES OF fossil remains reveal that during the past 570 million years or so, there have been major crises during which many life forms were destroyed.

Many hypotheses have been put forward to explain this mass extinction of organisms. In the last few years, the catastrophic theories have held sway, because the evidence points to an extreme and abrupt extinction of major groups of organisms. The catastrophic hypotheses comprise terrestrial as well as extra-terrestrial events. Recent reports favour extra-terrestrial events. Nobel laureate Luis W. Alvarez and his associates at the University of California, Berkeley, USA, have proposed that the great extinction of the marine reptiles, flying reptiles and dinosaurs, which occurred about 6.5 million years ago, was caused by the impact of a large asteroid with a diameter of 10±4 km (*Science* **208** 1095). Due to the impact, a large mass of matter was ejected into the atmosphere in the form of rocks. A fraction of this remained in the stratosphere for a long time, blocking sunlight. This suppressed photosynthesis which in turn, affected food supply and led to the extinction of organisms.



The figure shows the seasonal movement of the shadow of the terrestrial ring during the end of the Eocene period. The sunlight makes an angle with the ring equal to the sun's declination, which has a range +23.5 degrees to −23.5 degrees

An earlier hypothesis had proposed that gamma-rays from a supernova explosion could evaporate material from the lunar surface (SCIENCE TODAY, June 80, p. 11). On reaching the earth, this material would form a temporary ring which may have significantly influenced the terrestrial climate.

Now comes another hypothesis suggesting a cosmic origin of a less dramatic extinction of organisms at the end of the Eocene epoch, some 34 million years ago. The theory has been put forward by Dr. John. A. O'Keefe of the Goddard Space Flight Center, USA (*Nature* **285** 307). A review of the botanical data revealed a sudden change in the relative abundance of forest plants and this implied a 20°C drop in winter temperature. (Summer temperatures were not much affected.) Investigations of deep sea sediments revealed that a few abundant species of microscopic marine animals known as Radiolaria, which consisted of nearly two-thirds of the total population, vanished at about the same time. In the same sediments have been found a bed of tektites stretching from the Carribean to Australasia and the Indian Ocean. Tektites are lustrous glass objects, supposed to be solidified droplets of material ejected into the atmosphere from the impact of a large body on the earth (or the moon, according to some speculations).

According to Dr. O'Keefe, a cloud of interplanetary tektites showered the earth. Though a fraction of tektites—amounting to between 1,000 and 10,000 million tonnes—reached the earth, a large portion, about 25,000 million tonnes, was trapped above and formed an envelope around the earth.

Within a year, the cloud of tektites contracted and formed a ring. The outer radius of the ring has been assumed to be at a distance of 16,000 km inside the Roche limit and the inner radius at a distance of about 9,600 km above atmospheric drag. Such a ring could cut off sunlight in winter but not during summer (see figure). The ring lasted a few million years because of the various wear and tear mechanisms (SCIENCE TODAY, May 1980, p. 30).

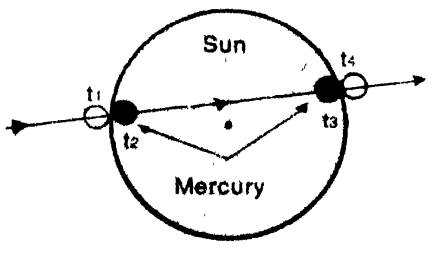
The idea that rings, rather than being an exception, could be common features of planetary systems gained foothold after the recent discoveries of the Saturnian-like rings around Uranus and Jupiter. It is interesting to know whether the earth had a ring around it. O'Keefe's hypothesis can be accepted only if it is proved that tektites can have cosmic origin.

JYOTI NEVATIA

Dr Nevatia is on the editorial staff of SCIENCE TODAY

Is the sun really shrinking?

DURING THE last decade and a half the sun has simply not been behaving properly, according to astronomers. The sun provided an ideal testing ground for theories about the stellar structure and especially about the nuclear energy generation processes. According to the standard, widely accepted and used theory, the fusion of hydrogen to helium (similar to hydrogen bomb) at the core generates the energy necessary to sustain the sun in its equilibrium. This energy diffuses through the outer layers and it takes about several hundreds of thousands of years to come out of the sun's bulk. On the other hand, the neutrinos, interacting very weakly, take only about eight minutes to reach the earth from the core of the sun. Hence, astronomers set out to measure the number of solar neutrinos reaching the earth, and to their dismay found that they were not getting as many neutrinos as predicted theoretically. One explanation for this can be that the core has somewhat cooled down and hence the number of neutrinos is less. This cooling of the core will be reflected in the solar luminosity only after hundreds of thousands of years. If this were indeed the case, the only way to verify this hypothesis will be to measure the diameter of the sun; the cooling of the core will reduce the energy generation and the sun will contract.



Sketch shows the transit of the planet Mercury in front of the sun as would have been seen from earth. The times of apparent external contacts t_1 and t_4 and apparent internal contacts t_2 and t_3 are recorded during these rare events, only 13 of which occur in a century.

Last year, two American astronomers, making a study of the historical record of observations at the Royal Greenwich Observatory over the past 150 years, concluded that during the last century the diameter of the sun has indeed decreased by about 0.1 per cent. However, very recent work by M.Y. Shapiro (*Science* **208** 51) has cast serious doubts on this result. Based on the observations of 23 transits of Mercury of the sun, between 1736 and 1973, he found no significant shrinkage during this period. The transits of Mercury are carefully catalogued because of their importance for the experimental foundation of the law of gravitation. Hence, Shapiro's conclusion is more reliable. This immediately poses the problem about the number of solar neutrinos. Perhaps the explanation lies in the latest discovery of neutrino oscillations (SCIENCE TODAY, June 80, p. 26).

S. RAMADURAI

Dr Ramadurai is with the Astrophysics Group, Tata Institute of Fundamental Research, Bombay

Energy bonus from fuel cells

BY-PRODUCTS are always thrown into the bargain during any processing. The efficient use and recirculation of by-products are important from the point of view of economy and conservation. Energy is one such by-product routinely handled by the chemical industry.

The oxidation of ammonia to nitric oxide, a basic step in the manufacture of nitric acid, liberates a large amount of energy. This exothermic reaction involves a Gibbs free energy of around 65 Kcal/mole of ammonia at 1000°K (or around 800°C). In standard chemical processes, this energy becomes available as thermal energy. If it could be made available as electrical energy, the conversion and use of this energy could be much more efficient. The typical solution would be an electrochemical process, a fuel cell, which converts ammonia to nitric oxide and makes this energy available as electrical energy.

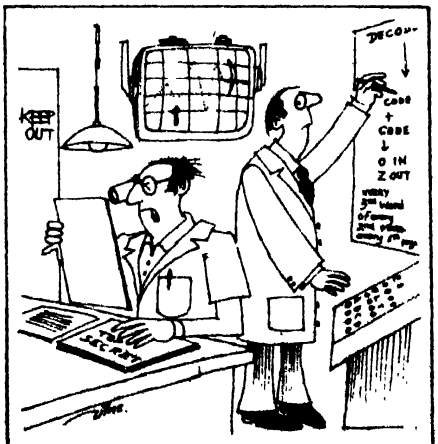
Low and medium temperature fuel cells have been tried, but with little success. It has been found that nitrogen is the only oxidation product. Though only on a laboratory scale, C. G. Vayenas and R. D. Farr report in *Science*, **208** 593, a successful experiment using a high temperature solid electrolyte fuel cell.

The fuel cell [NH_3,NO, N_2, Pt/Z_rO_2 (8 per cent Y_2O_3)/Pt, air] consisted of an 8 mole per cent yttria stabilised zirconia tube with fairly thick walls (about 2 mm). Platinum electrodes were deposited on the inside and outside surfaces of the wall. The outside electrode was exposed to air. Good results were obtained between 900°K and 1,200°K. Above 1,200°K, however, the decomposition of ammonia directly to nitrogen and hydrogen was very fast. When high flow rates were used, a power output of the order of a milliwatt per square centimetre of solid electrolyte was obtained but only 5 per cent of the reacted ammonia was converted to nitric oxide. Significant results were obtained when low molar flow rates were used. Though this led to a substantial drop in power output—about seven microwatts per square centimetre—significant proportion of reacted ammonia could be converted to nitric oxide. Thus when 82 per cent of the ammonia reacted, 64 per cent of it could be converted to nitric oxide and when 24 per cent of the ammonia reacted, as much as 97 per cent could be converted to nitric oxide.

This has yet to go a long way before it becomes industrially useful. But the report also describes the parameters that control the reaction. The rate-limiting step is the diffusion of oxygen ions through the solid electrolyte. Thinner electrolyte walls have to be used to increase the yield of nitric oxide per reacted ammonia at higher flow rates. Mechanically strong supports deposited with a stabilised zirconia film could be an answer but would involve improving the existing technology of thin stabilised zirconia films. An alternative could be developed from other highly conducting solid electrolytes. This does not yet mean an energy bonus for nitric acid plants; the payment, so to say, has not been made, but the bargain has been struck.

P. V. PARANJAPE

Mr Paranjape is on the editorial staff of SCIENCE TODAY



You are right. This is an article on coding and decoding after all!



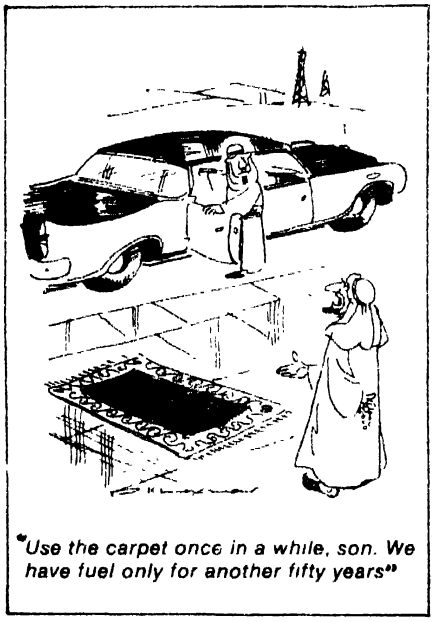
"Doesn't start? Put alcohol. And also crushed ice, soda, twists of lemon peel and a dash of bitters."



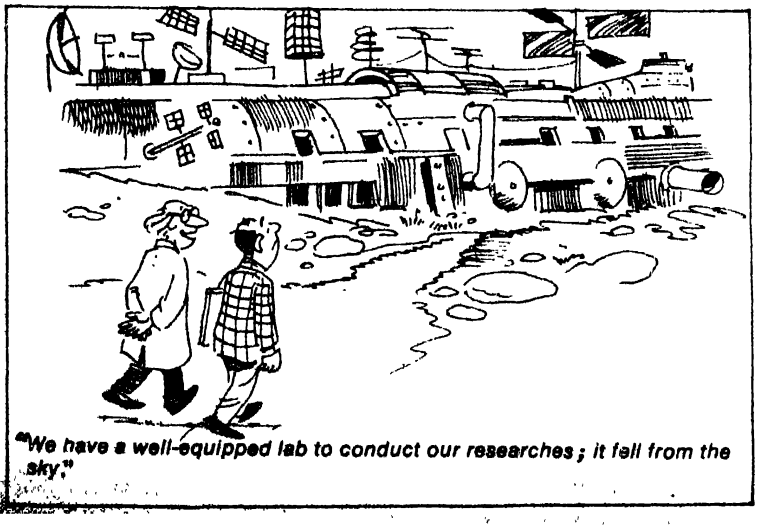
"The new drug you gave, doctor, has produced a funny side-effect!"

This World of Science!

By R.K. Laxman



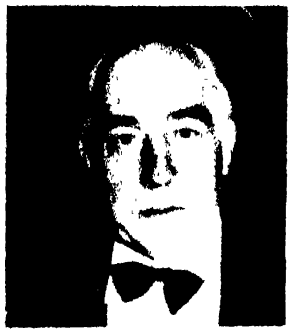
"Use the carpet once in a while, son. We have fuel only for another fifty years"



"We have a well-equipped lab to conduct our researches; it fell from the sky."

... and of scientists

CAN a scientist use imagery to describe a phenomenon he is studying? The answer, however ridiculous it may sound, is in the affirmative, according to



Prof Bohr

Neils Bohr who told Heisenberg: "When it comes to atoms, language can be used only as in poetry. The poet, too, is not nearly so concerned with describing facts as with creating images."

***

IT IS now common knowledge that a surgeon must also be a physician. But, as early as the 16th century, Paracelsus, the Swiss physician and alchemist, said: "Where the physician is not also a surgeon, he is an idol that is nothing but a painted monkey."

***

NOT CONTENT with his secure place in science as well as philosophy, Newton also tried his best to be a theologist by reducing scriptural prophesies and revelations to the maximum simplicity and clarity, following the method of physics. He showed that "the earth will continue to be inhabited by mortals after the Day of Judgement for ever and ever. On the day of his Coming, Christ will judge not only the dead but also the quick (the living); hence, the dimensions of the New Jerusalem will have to be big enough to accommodate the crowd of those who are chosen." He analysed and calculated that "its length in each dimension will be the cubic root of 12,000 furlongs."

S. N. MUNSHI

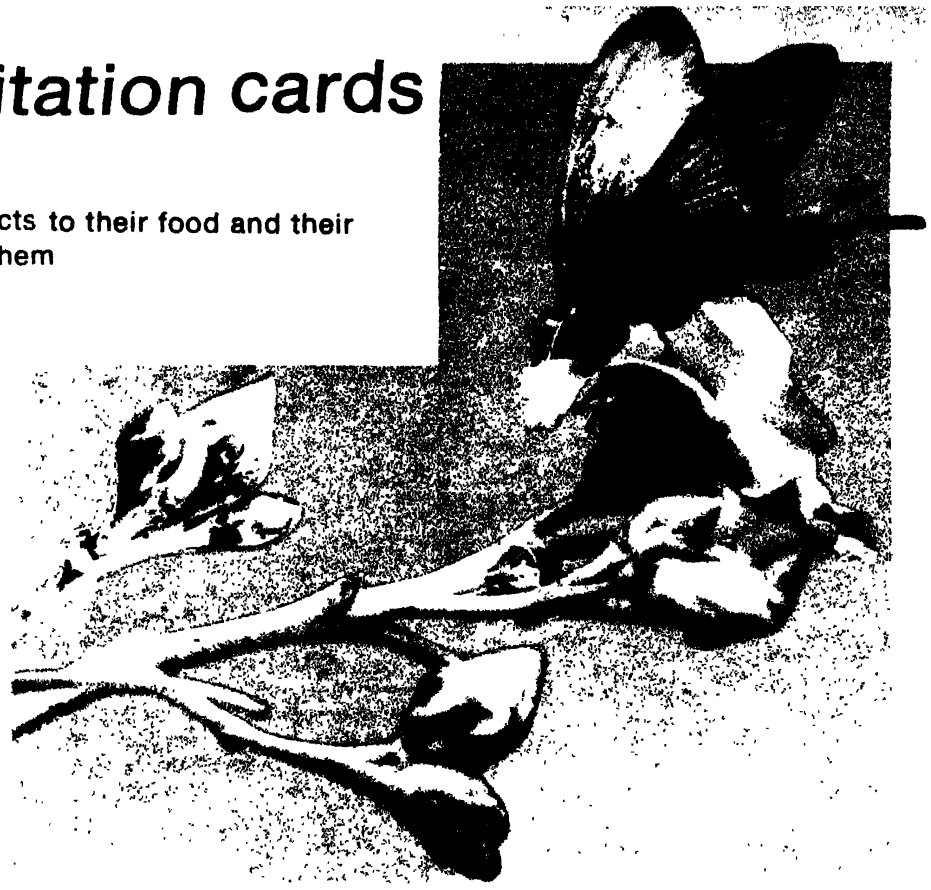
On 2 December, 1942 the first controlled nuclear chain reaction was demonstrated under the West Stands of the University of Chicago football stadium. According to George Weil, who participated in the experiment, the world's first nuclear reactor operated for 28 minutes before Enrico Fermi ordered the chain reaction stopped. At that point Eugene Wigner produced a bottle of Chianti. After celebrating the success of the experiment, the Chianti bottle in its wicker basket was autographed by the participants. This turned out to be the only written record of that historic experiment by those who had been present at the experiment on that day.

C. D'S.

Olfactory invitation cards

K.N. Saxena

Smells that naturally guide insects to their food and their mates can be used to misguide them



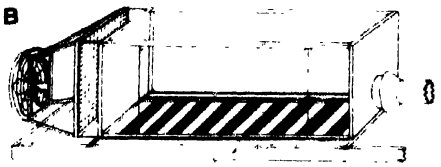
SMELLS are all around us; some are quite pleasant, while others are repulsive. Although smells play a relatively subordinate role in human life, in many animals they may even control some of their vital processes. A large number of insects belong to this category: smells guide insects to their food, help them to locate appropriate places for laying eggs, find them sexual partners and in some cases even ensure social communication and co-operation.

Smells which influence insect behaviour are important to us since insects interact with us, both beneficially and harmfully. Insecticides have been the most common weapons against insect pests. But the large-scale use of insecticides creates new problems. For example, most insecticides tend to leave residues which are harmful to man. Also, many insect pests have developed immunity against insecticides, which, as a consequence, have become ineffective. Some insects which are a menace in large numbers may be actually beneficial in smaller numbers. One example is the Norwegian bark beetle, *Ips typographus*. When its population exceeds bounds, this insect attacks even live Norwegian spruce trees in search of food, thus destroying forests, whereas, in smaller numbers, it helps in the rotting of the dead spruce wood. In such cases, total extermination by insecticides could result in throwing the baby out with the bath water. Exploiting smells for the control of harmful insects by manipulating their behaviour offers the possibility of a new solution to such problems. A considerable amount of work is now being devoted to learning which smells and how they influence the lives of insects.

Many smells which influence the behaviour of insects come from substances produced by the insects themselves. An equally large number comes from other sources in the environment. All these substances contain some volatile chemical constituents



Fig 1. Methods for testing attraction of insects to smells from different sources. A . The citrus butterfly larva (or any other similar crawling insect) is allowed to move on a grid along one rib towards its intersection with another rib. The odorous chemical is impregnated on a wick which is placed on one side of the intersection at the desired distance. When the larva reaches the intersection, it may move forward or turn to move along the transverse rib towards the wick or towards the opposite blank side. On the basis of tests with several larvae, a greater percentage turning towards the wick than towards the blank side would show their attraction to the test odour source



B . A wind tunnel which is generally used for testing attraction of flying insects to odours, for example, sex-pheromones A gentle breeze is blown through the odour source by a blower fan from one end of the tunnel. The odour-borne air stream passes out of the tunnel at the opposite end. A flying insect released in the tunnel generally goes down the wind when there is no odour. But, on introducing an attractant odour the insect would fly upwind towards the odour source

whose vapours can be detected from a distance by insects On detecting these odours, insects react in different ways One category of insect behaviour controlled by smell is orientation which involves movements in relation to the odorous substance Certain substances emit smells which drive away insects, these substances act as repellents Other smells stimulate the insects to approach the odour source or, if it is already at the source, to remain there Such odorous substances are known as attractants

Some chemicals may act as attractants at a lower concentration and as repellents at a higher concentration The term attractant refers to a substance that attracts insects from a distance through its odour The term is sometimes loosely used for any substance on which insects may congregate If such a congregation is the result of detection of the substance *after* the insect comes in contact with it, rather than converging on it from a distance the substance strictly speaking, cannot be called an attractant For example a sugar grain on which flies congregate is not an attractant it is detected only by its taste after the flies come into contact with it Also, it is taste which keeps them from moving away until they are satisfied

Repellents even though they can keep insects away and provide protection, are not of much use in the control and monitoring of insect populations Attractants however can be used in different ways for controlling insect pests In recent years the study of various attractant odours is gaining attention

Food and ovipositional attractants

Insects show strong preferences or dislikes for certain plants and animals as food and/or for laying eggs Generally, the preferences for food and for egg-laying (ovipositional) are inter-connected That is why, food and ovipositional attractants are considered together Females tend to choose egg-laying sites which would enable the newly hatched young to feed on the preferred food The same chemicals may serve as food attractants for one insect and as ovipositional attractants for another A food attractant for the larvae may be an ovipositional attractant for the mature insect

Almost all the odours which distinctively guide insects to their preferred host plants or animals are emitted by the hosts Such chemicals are called *kairomones*, a term suggested by Brown, Eisner and Whittaker in 1970 Kairomones are substances which are produced by an organism to influence the behaviour of other species in a way which benefits the other species This is in contradistinction to *pheromones* a term coined by Karlson and Lüscher in 1959, which are substances secreted to the outside by an organism to influence the behaviour of other members of its own species The kairomone exo-brevicomin secreted by the pine bark beetle *Dendroctonus brevicomis* has been found to attract its predator *Tamnochila chlorodia* The carbon dioxide exhaled by humans and certain amino-acids, particularly alanine and lysine, are believed to attract female mosquitoes Smells thus play their part in the complex interdependence which characterises the animal and plant world

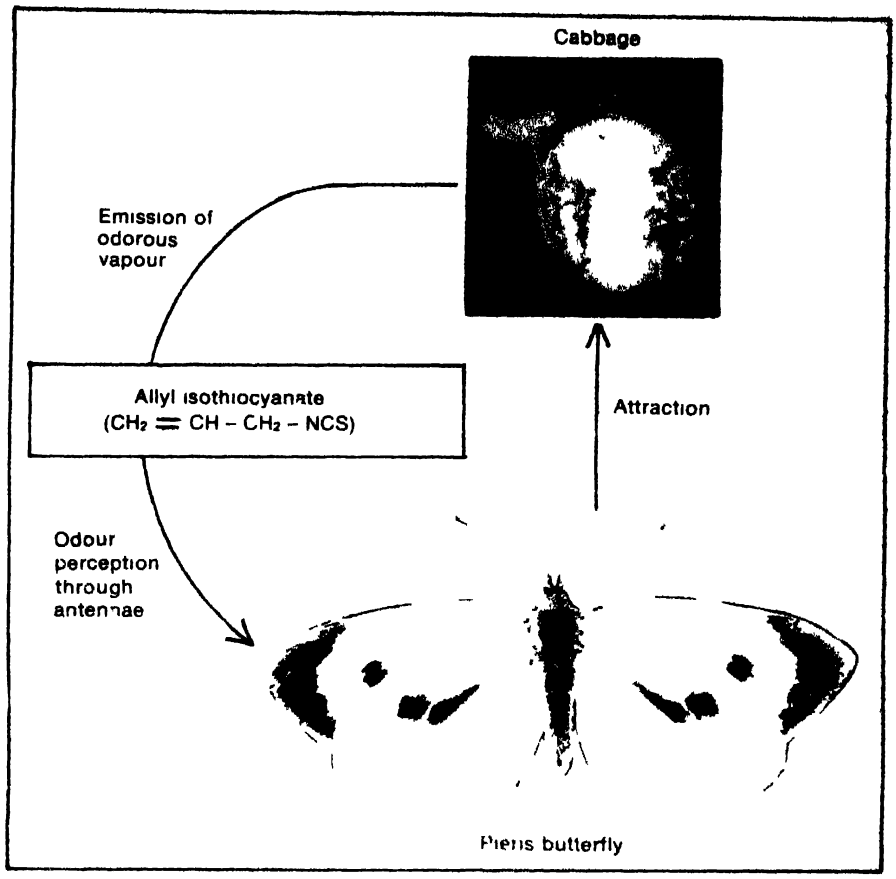


Fig 2 Attraction of *Pieris* butterfly to a crucifer plant (cabbage) in response to the odour of certain isothiocyanates which are volatile constituents of the plant

Attractants are specific But the degree and kind of their specificity is strikingly diverse Some group of insects are solely attracted to a specific group of plants Thus, insects like the cabbage butterflies, *Pieris brassicae* and *Pieris rapae*, diamond back moth, *Plutella xylostella*, and cabbage root fly, *Delia brassicae*, confine their attack to plants of the family Cruciferae which includes cabbage, cauliflower, radish and mustard Interestingly, this attraction also brings out the link between the food and ovipositional attractants, the adults of these insects are attracted to these plants for laying eggs and the larvae, for feeding The cruciferous plants contain certain chemicals commonly known as 'mustard oil glucosides which on enzymic hydrolysis liberate mustard oil, most of which is a mixture of isothiocyanates. These isothiocyanates are volatile and emit characteristic odours The above-mentioned insects have been found to be strongly attracted to certain isothiocyanates, particularly to allyl isothiocyanate The cabbage root fly is also strongly attracted to the ethyl , butyl-, phenyl-, and cinnamoyl-isothiocyanates as well

Sometimes the different parts of a plant are specifically infested by different insects The plants of family Malvaceae, which includes cotton, is infested by a number of insects The leafhopper *(Amrasca devastans)* feeds on the leaves, the red cotton bug *(Dysdercus koenegii)* feeds on the seeds and the notorious cotton boll weevil *(Anthonomus grandi)* on the cotton boll We have found that the leafhopper is attracted by a mixture of the chemical constituents of the leaf including alpha-pinene and camphene On the other hand, a mixture of the triglycerides and a flavonoid pigment which is present in the seed kernel attracts the red cotton bug The cotton boll weevil is attracted to

the odour of a mixture of volatile chemical constituents of the cotton plant particularly (-) -- pinene, (-)-limonene, (-) -B - caryophyllene, (+) - B bisabolol, caryophyllene oxide and two other sesquiterpenoids.

Some insects may be attracted to a mixture of chemical constituents of definite proportions. Some volatile substances, namely, trans-2-hexen-1-ol, hexenol-1, *cis* 3-hexen-1-ol, trans-2-hexenal and linalool, occur in plants of families including those of the family Solanaceae to which belong potato, brinjal and tomato. The proportions of the four chemicals, however, vary from one plant to another. The Colorado potato beetle *(Leptionotarsa decemlineata)* has recently been shown to be attracted by a mixture of definite proportions of these volatile chemicals as present in potato and some other solanaceous plants.

Even closely related species of insects often show a marked difference in the kinds of smells which influence them. The butterfly *Papilio polyxenes* confines its attack to the plants of the family Umbelliferae which includes coriander and carrot. These plants emit characteristic odours which have a basic resemblance. The larvae of this butterfly have been shown to be attracted to these plants by their odours. Although the odours of different umbelliferous plants are the result of mixing and blending of several chemicals, the most important constituents contributing to the resultant odour which attracts the butterfly larvae were found to be methyl chavicol, anethole, anisic aldehyde, paramethoxy benzoic acid, methylnonyl ketone, carvone, coriandrol and sedanonic anhydride. A closely related species *Papilio demoleus*, known as lemon butterfly, however, shows preference for a totally different type of plant; it attacks citrus plants like lemon, orange and grapefruit. The active chemical constituents attracting the lemon butterfly caterpillar have been found to be citral, citronellal, citronellol and 1-limonene.

But attractants do not always guide insects to food and egg-laying sites. Instead, they may lead them into the jaws of death. Certain insectivorous plants use these attractants to trap insects, for example, the bladder flower plant *(Araujia sericofera)* which grows in many countries of the American continents. It has been recently found that the bladder flower emits a volatile constituent phenylacetaldehyde - which lures the insects to their death.

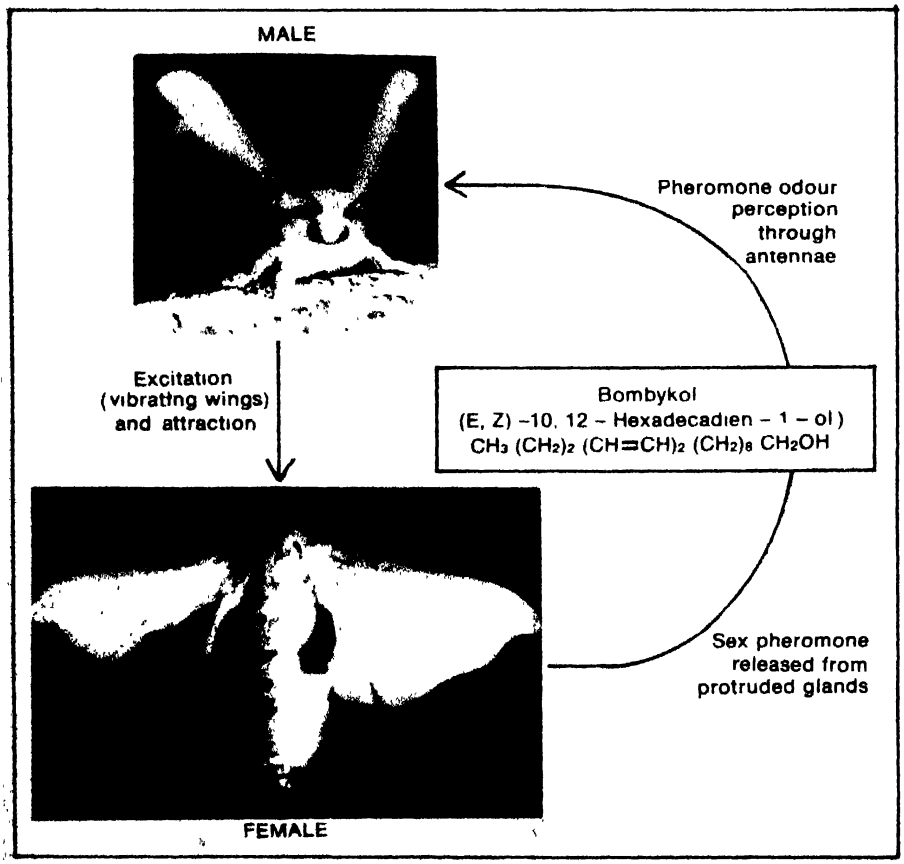


Fig 3. The mulberry silkworm *Bombyx mori*. The female moth protrudes the glands at the end of its abdomen and releases its sex pheromone (bombykol). When the pheromone odour is perceived by the male through its antennae, it becomes sexually excited, begins to vibrate its wings and approaches the female for mating

Sex attractants

The odorous substances secreted by one sex and influencing the sexual behaviour of the opposite sex are called "sex pheromones". These pheromones can be divided into three categories. The first type are the sex attractants which attract the members of the opposite sex for mating. The second type includes the aphrodisiacs, which excite and make the opposite sex receptive for mating and also serve as aids in the mating process. The third type are the inhibitors which reduce the attraction of the members of a sex to the attractant pheromone emitted by the opposite sex. In some cases, the same pheromone may serve as both sex attractant and aphrodisiac. Of the sex pheromones, the attractants have been the most extensively studied.

The fact that the scents of female insects can attract the males for mating was noted as early as 1879 by the naturalist Jean Henri Fabre. Slowly, more and more cases of sex attractants began to be reported and evidence began to pile up that the odours were certainly involved in bringing the two sexes together and by the nineteen thirties, the phenomenon had been well established. The chemical analysis and identification of the sex pheromones had to wait until much later. The breakthrough in this direction was made by Adolf Butenandt and co-workers in 1959, 80 years after Fabre's discovery, when the chemical identity of the female sex pheromone of the mulberry silkworm moth was established as (E, Z)-10, 12-hexadecadien-1-ol, commonly termed as bombykol.

This was not accidental. The isolation and identification of sex pheromones posed special difficulties, since they are produced by insects in minute quantities. Butenandt and co-workers, using about half a million female moths, finally obtained a mere 12 milligrams of the derivative for establishing the identity of the pheromone. By the same token, about 30 years of painstaking chemical analyses went into the isolation and identification of the gypsy moth sex attractant by the US Department of Agriculture. It took the abdominal tips of half a million female gypsy moths to obtain 20 mg of the pheromone, which was finally identified in 1960. No wonder that the arduous task of collecting sufficient quantity of pheromone for an analysis took so long.

The implications of such minute quantities are enormous. The gypsy moth female would have a total of 0.04 microgram of attractants at her

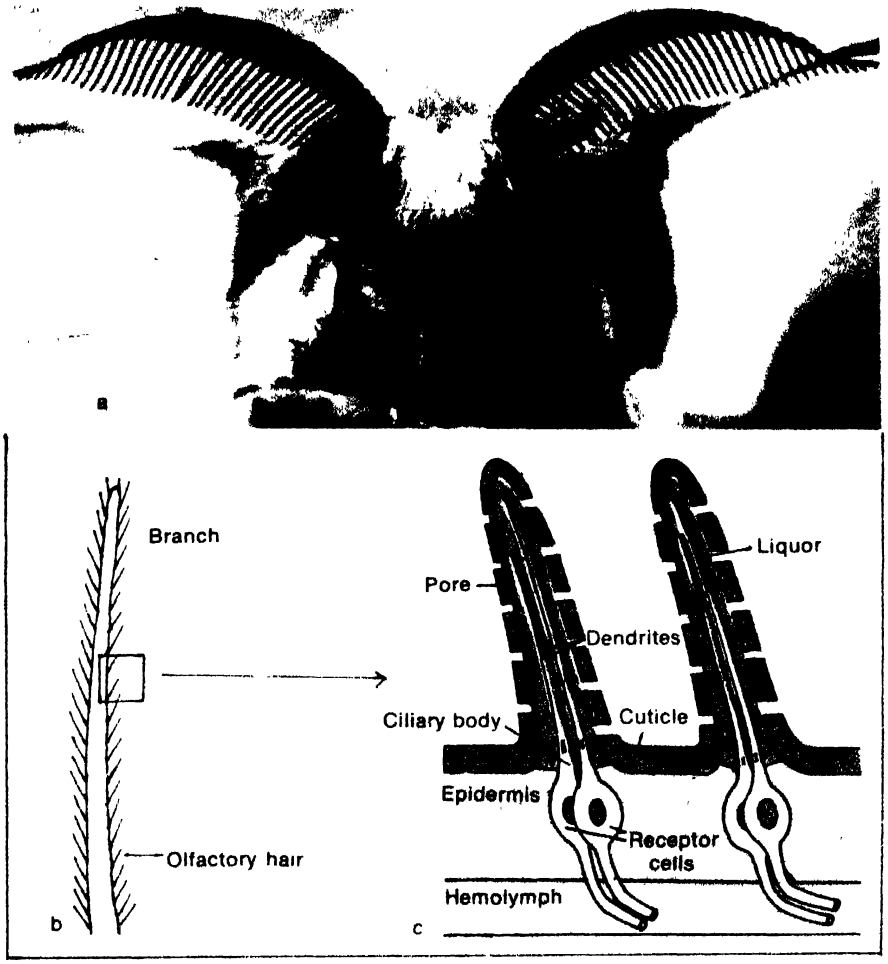


Fig 4. The antennae of the male silk moth (a) of the species *Bombyx mori* Half of the odour-receptor cells in the male's antennae respond to a single substance, bombykol. The length of the male's antennae is six millimetres Note the fine structure of the antenna branch and its olfactory hairs (b). The branches of the antenna and the olfactory hair form a fine mesh through which the air flows. The olfactory reception takes place at the hair shown in magnified longitudinal section at (c). Each olfactory hair is innervated by the dendrites of two receptor cells. Bombykol molecules diffuse through the pores. This gives rise to an electrical charge in the membrane of the receptor cells

abdominal tip. In spite of the infinitesimal amounts involved, the remarkable potency of the attractants to attract the opposite sex over long distances has been established beyond doubt.

The sex pheromones produced by the females of some insects have only a single chemical constituent which attracts the male. The female black carpet beetle *Attagenus megatoma* has been reported to secrete a single-component pheromone which is an isomer of tetradecadienoic acid. The pheromone of the female moth *Heliothis zea* also has been found to contain a single attractant constituent—an isomer of tetradecenal. Even the common housefly *(Musca domestica)* female attracts its male by a single component pheromone now identified as (Z)-9-Tricosene and named muscalure after this common pest.

Some sex pheromones contain two chemical constituents. But most of these multiconstituent pheromones tend to be mixtures of closely related compounds in definite proportions. The females of the pink bollworm *Pectinophora gossypiella*, a serious pest of cotton, produce a male-attracting pheromone which is a mixture of two isomers of hexadecadienyl acetate in equal quantities. The sex pheromone of the female *Heliothis armigera,* another pest of cotton and of pulses, is reported to be a mixture of certain isomers of two closely related compounds, hexadecenal and tetradecenal. The diamond back moth *Plutella xylostella,* a world-wide pest of cruciferous crops, secretes a sex pheromone which is a mixture of certain isomers of hexadecenal and hexadecenyl acetate and certain minor components. The females of the moth *Spodoptera litura* which attack such diverse plants as tobacco, castor, and cotton secrete a pheromone which is a mixture of two isomers of tetradecadienyl acetate.

Odours elude a scientist

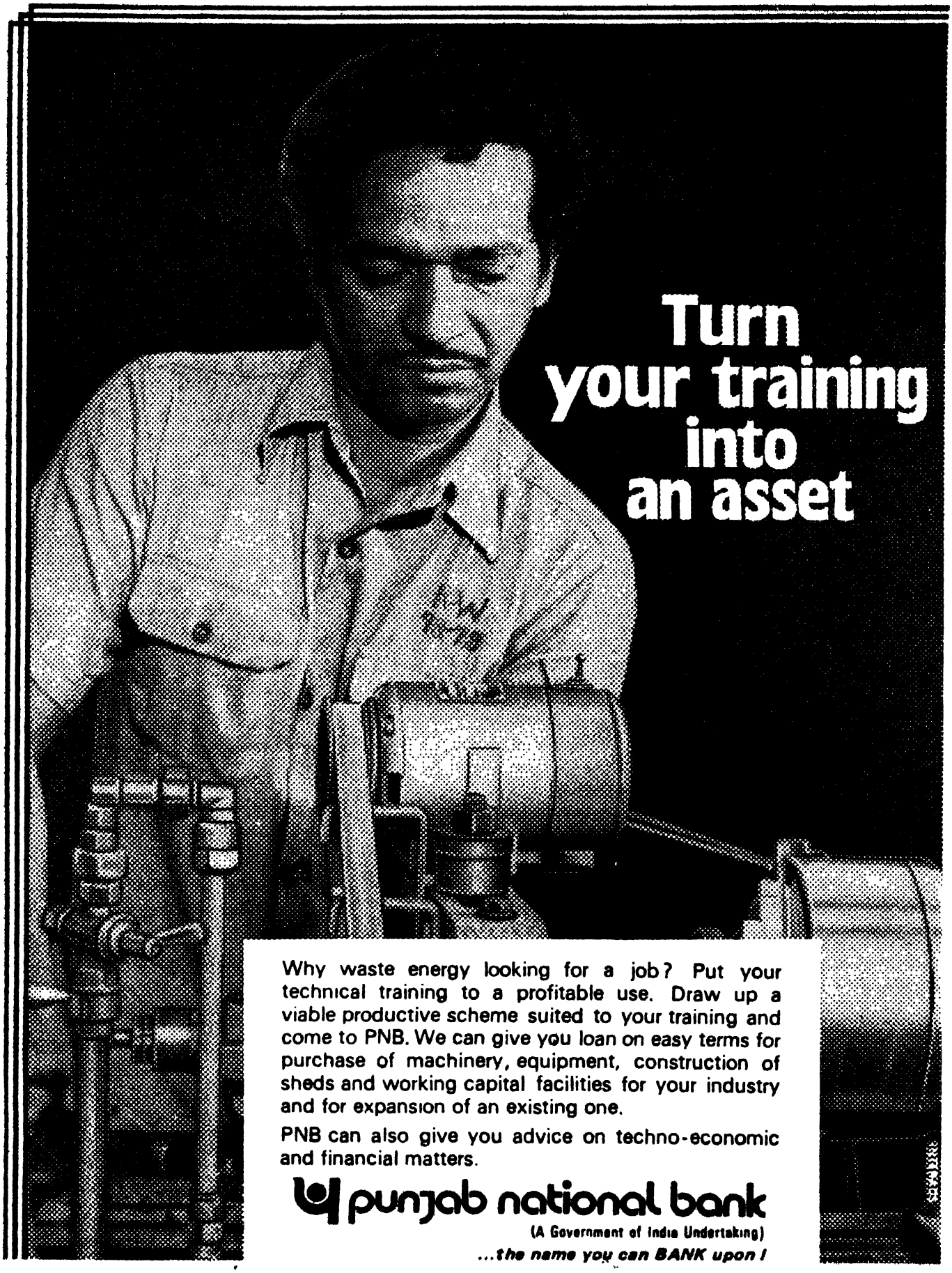
JEAN HENRI FABRE was a 19th century French naturalist. He was naturally drawn to insects and his insatiable curiosity was responsible for many of our insights into the lives and habits of insects. He was looking for a certain moth whose larvae fed on oak leaves and was rewarded one day when he found a cocoon of the insect on a leaf. Fabre placed the female moth which emerged from the cocoon in a cloth cage near an open window of his house. Within 15 hours, more than 60 male moths were mobbing the cage!

His curiosity aroused, Fabre began a series of experiments. He removed the female, and placed its newly empty container near the window. In spite of the female being absent, the container was mobbed by male moths. He then placed the female in an airtight transparent container and presented it to the males. However, though the female was clearly visible, the male moths would not as much as cast a glance in its direction. He tried to drown the room with strong smells like naphthalene, hydrogen sulphide and tobacco smoke yet the moths sailed straight to their target, the female smell, through all these fumes. He replaced the female by another species, the emperor moth, and this time male moths of that species appeared. For eight successive nights, according to Fabre, "males seemed to take possession of the house"

Everything clearly pointed to the fact that smell formed the basis of this mechanism. Yet, Fabre could not bring himself to believe that odours were responsible for the attraction. The infinitesimal quantities of odorous substances involved could not even be dreamt of, at that time, as being the root of the phenomenon. Moreover, how could sensitivity still be retained in the face of strong odours like naphthalene and tobacco smoke drowning the insignificant amounts of odour from the female? Fabre considered and then rejected the mechanism of odours as being responsible.

He proposed another mechanism. He guessed that the females generated waves which were propagated through air and received by the male moth's antennae. He even proceeded to verify the hypothesis. He found that males deprived of their antennae hardly ever succeeded in locating the female! But Fabre didn't know that the chemoreceptor organs (the nose) lie on the antennae of the males. Like Joseph Priestley who in spite of his discovery of oxygen, died as a firm believer in the phlogiston theory of combustion, Fabre was convinced of the wave nature of insect attraction!

K. N. S.



Why waste energy looking for a job? Put your technical training to a profitable use. Draw up a viable productive scheme suited to your training and come to PNB. We can give you loan on easy terms for purchase of machinery, equipment, construction of sheds and working capital facilities for your industry and for expansion of an existing one.

PNB can also give you advice on techno-economic and financial matters.

punjab national bank

(A Government of India Undertaking)

...the name you can BANK upon !

Printed circuit boards from porcelain-coated steel

PRINTED circuit boards (PCBs) are used practically in all types of electronic equipment—from domestic radios and TVs to more complex industrial and aerospace systems. The PCB is a copper-clad dielectric material. It consists of an electrically conductive copper pattern on one or both sides of a supporting dielectric laminate. The choice of materials used for the fabrication of the PCB laminates depends upon the environment in which the final product will operate.

Most common laminates fall into two broad categories, those with phenolic bases and those with epoxy bases. Phenolic boards are generally fabricated with paper fillers while epoxy boards use glass fibre fillers. Often, however, the equipment has to withstand severe environmental conditions such as extremes of vibration, shock and heat. Though many of the electronic components mounted on the PCBs are capable of operating in such hostile environment, the circuit boards themselves may break down. In these applications, special materials, specifically tailored to endure environmental extremes, have to be used. Such special materials are generally expensive.

A new type of PCB fabrication technique for use in such applications, as well as other low-cost, high-volume consumer and industrial products, is now being investigated by over 200 firms in the USA. This technique provides inexpensive circuit boards made from porcelain-coated steel; the porcelain surface allows the board to withstand high temperatures and the steel core provides rigidity that combats failures from vibration.

The fabrication of the steel boards is simple in principle. Initially a board of required size is cut from an ordinary low gauge (typically 20 gauge) steel sheet. After cleaning and roughening up its surface, this board is dipped in porcelain enamel, dried and fired at high temperature. The initial cutting (or milling or stamping) process is also used to simultaneously cut and coin board holes, too. Coining provides bevelled edges around each hole to facilitate even porcelain coverage and easy insertion of component leads.

The enamel-coated board can be processed much like a hybrid substrate. The conductor paths are silk-screened over the porcelain surface. Circuits on these boards can consist of both small hybrid electronic components and large power handling or display devices. The smooth porcelain surface is compatible with high temperature firing, facilitating resistor bonding. Thick or thin film resistors can thus be bonded to the board through conventional screening, evaporating or firing procedures. Unencapsulated transistors and integrated circuits can also be bonded to the porcelain substrate. The steel core makes the board rigid enough to take large and bulky components. Whereas the conventional PCBs must be flat because they cannot bend, steel cores can be fabricated into irregular shapes, if needed, to become part of the product chassis.

Above all, steel boards provide built-in heat sinks and ground planes. Though the enamel surface is a good thermal insulator the porcelain can be selectively etched or sandblasted to allow heat sinking of high power devices directly to the steel core. None of the plastics used in conventional PCBs is a good thermal conductor and the steel core boards thus eliminate the need for extensive heat sinks. A 2 watt precision resistor operating at the rated power, for example, on an epoxy glass board will be 25°C hotter at its surface than the same resistor mounted on such a porcelainised steel substrate. If, further, the steel core is put in metal-to-metal contact with the system's chassis the situation will be still improved. In a similar manner, the core can also be used to shield the circuits from electrical noise.

JAY RAJA
Mr Raja is with the Vikram Sarabhai Space Centre, Trivandrum

Xerographic copying of X-ray images

DUPLICATION of X-ray images is needed for many purposes. For example, some medical institutions give the patient only a written report, retaining the X-ray films of all sophisticated investigations concerning heart, kidney, brain, etc. Hence, patients who wish to consult some other hospital later on are hampered by the lack of X-ray films of the earlier investigation. Medical graduates may also need duplicate copies of interesting X-ray films for inclusion in their theses and for publication of research reports. For this purpose, the usual silver halide photographic copies are used. This process proves to be expensive, especially when many copies are desired or when several X-ray films are to be duplicated. For making exactly identical copies of X-ray films, Kodak X-omat duplicating films (USA) are used.

However, both these processes have certain drawbacks. For example, the facilities for both these processes are available mostly in academic institutions. Hence, these processes are not accessible to the patient and his relatives, who wish to get duplicate copies of their X-ray films.

The author, in 1978, developed successfully an alternative process for duplicating X-ray images on plain paper by xerographic process. This technique has many advantages over the other two processes. One is that the same xerographic equipment used for reproduction of documents, in which a selenium-coated metal plate is employed as a photoconductor, can be used as well for X-ray images.

In the conventional technique for document reproduction, bright light is directed on the document kept at the focus of the lens of the xerography equipment. For X-ray film duplication, light passing through the X-ray film was utilised to cast the image. X-ray film was attached to the illuminated X-ray viewer and the film was kept at the focus of the lens system. The light kept at the back of the film should be of optimum intensity and diffused. The image will not be cast satisfactorily, or not cast at all, if the intensity of transmitted light is either too bright or too low. The rest of the process is the same as in document reproduction. Also, the amount of toner should not exceed the quantity required to yield a satisfactory image. Further, the selenium plate should not have any flaws or scratches.

To study whether finer details in an X-ray film can be reproduced in the xerographic image, a selective internal carotid angiogram was selected for duplication. A comparison of the xerographic copy of the X-ray image with that of the photographic copy showed that the xerographic copy offered all the necessary information present in the X-ray film or in the photographic copy. In addition, clearer definition of arteries in the xerographic copy than in the other was noteworthy.

Since the xerographic equipment is most widely used even in small towns and market areas, copies can be obtained by patients when desired. Secondly, plain paper copying makes the process very cheap. For example, a copy can be had from the market for 50 paise. Whereas photographic copying, though undoubtedly excellent in quality, is highly expensive; even if the negative is available, a print would cost Rs.2. Further, the photographic process is very slow because a negative has to be made initially and then prints..

Xerographic copies can be made either of the same size as the X-ray film or in mini size. If a miniature copy is desired, as for students' theses, the film is to be kept far from the lens of the xerographic system while exposing. This technique may prove to be a boon particularly for students of radiology, because it is cheaper than the photographic process.

M. A. PADMANABHA RAO

Dr Rao is with the Department of Nuclear Medicine, All-India Institute of Medical Sciences, New Delhi.

Clean fresh breath... Strong healthy teeth



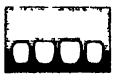
with Colgate Dental Cream

Brush your teeth with Colgate after every meal It protects you just the way dentists recommend all over the world

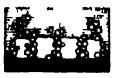
Bacteria grow in food particles left between your teeth These can cause bad odour and, later, painful decay

So always brush the Colgate way right after eating It s proven most effective to freshen your breath, whiten your teeth, and fight decay

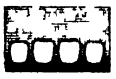
How Colgate's trusted formula works



Odour and decay causing bacteria grow in food particles trapped between your teeth



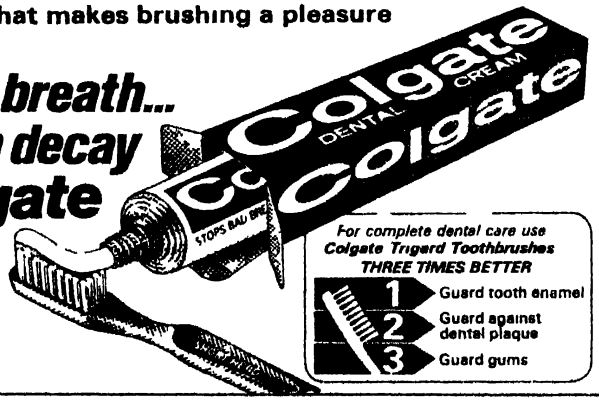
Colgate s unique active foam reaches deep to remove dangerous food particles and bacteria



The result attractive white teeth fresh breath confidence protection against decay

Colgate has the fresh, minty taste that makes brushing a pleasure

Stop bad breath... Fight tooth decay with Colgate Dental Cream



For complete dental care use Colgate Trigard Toothbrushes THREE TIMES BETTER

1 Guard tooth enamel
2 Guard against dental plaque
3 Guard gums

DC G 73 80

Science and technology plan —pitfalls and promises

FROM the latest information available, the expenditure on S and T in 1976-77 was about Rs. 450 crores which represents about 0.63 per cent of GNP (Table 1). This may be compared with 1 per cent of GNP recommended by the National Committee on Science and Technology (NCST) in 1973, or with 2 to 3 per cent spent by the highly industrialised countries. However, it is to be noted that this proportion of R and D expenditure has been growing from a low 0.23 per cent in 1958-59. Our stock of scientific and technological manpower has also been growing at about 9 per cent a year for over 20 years and is now estimated to be about 2 million. India today has the third largest complement of qualified S and T manpower in the world, next only to the USSR and the USA The S and T base has also enabled the nation to build a large and varied industrial infrastructure and India now ranks amongst the industrialised countries in the world.

Over the years, as the S and T infrastructure has grown, there has also been a growing concern that benefits from science and technology have not reached the ordinary man, but have mostly accrued to the upper echelons of society: Further, though self-reliance has been a basic tenet of our policy during the last couple of decades, and a substantial technological competence and a capability to manufacture a wide range of industrial products have been built, including in sophisticated areas like atomic energy, the development of modern industries in the country has continued to depend on borrowed technology, as brought out in Table 2 showing an industry-wise break-up of foreign collaboration cases approved yearly during 1969-78. The total volume of remittances made by foreign companies in India and Indian companies set up with foreign collaboration for technical knowhow and royalty during 1969-70 to 1976-77 has been shown in Table 3.

The twin objectives of the S and T policy will be: (a) to secure for the people, particularly those in the rural areas, all the benefits that can accrue from the acquisition and application of scientific knowledge and research, to remove unemployment and fulfil their basic needs, to enhance the quality of their life, and to enable them to realise their full human potential, and (b) to improve the quality and expand the quantity of the S and T effort, and harness the S and T capability for enhancing self-reliance.


This is an abbreviated version of the Science and Technology chapter of the [illegible] Plan, published [illegible] The draft, [illegible] and a new draft is likely to be prepared by the end of the year. The options outlining the conceptual framework and the objectives of the science and technology policy in the draft are given here with a view to promoting a wider debate before the Plan is finalised. In the subsequent months, Science Today will also publish views and comments on the various issues involved.

Well-defined links

If our S and T infrastructure is to make a greater impact in these domains, the S and T activity has to be deliberately planned and purposefully directed towards the fulfilment of national goals, by enmeshing an S and T plan into the socio-economic plan. This process has barely started during the last plan period, and needs to be considerably strengthened by building well-defined linkages between the S and T capabilities of our higher education institutions, research laboratories, design organisations, production agencies, and the problems that matter. Identification and promotion of such linkages demand a greater and more precise awareness on the part of the decision-makers in each socio-economic sector at central, state, district and block levels, of what contribution S and T could make to the improvement of products and services in the sector concerned. It also calls for a related strengthening of the S and T planning machinery at each of these levels. No less important is a change in the attitudes, value system and content and quality of the training of the scientists, in fact, of the academic community in general.

Though S and T hold out the promise of fulfilling basic human needs and improving the quality of life of the people, translating it into realities, however, has socio-political dimensions. It is, in this context, important to draw a clear distinction between two categories of problems: (a) those which can be solved immediately, using existing knowledge, possibly with some adaptation, and (b) those where research and generation of new knowledge is essential.

New knowledge is certainly necessary in areas such as new varieties of seeds, nitrogen-fixation through biological or chemical methods, biological control of pests, photosynthesis, new uses for various local plants and other materials, recycling of waste products, new sources of energy, especially those suited for decentralised exploitation, new materials, improvement in the productivity of soils, better understanding of parasitic diseases, fertility control, etc. However, the fulfilment of basic needs of food, health, housing, fuel, water supply, sanitation, basic education, etc is largely dependent on the use of existing knowledge and expertise. Therefore, what is needed is socio-political decision to utilise the S and T infrastructure and capability, which already exist, and to commit, financial, administrative and organisational resources into the priority sectors, for example, the minimum needs programme. Recent progress in agriculture has underlined the contributions that S and T can make to national development if the necessary levels of financial and managerial inputs are provided on a sustained basis to a priority area of social relevance. Now that these commitments are being made at the socio-political level, it becomes important to devise instrumentalities for corresponding commitment in the S and T sector and a strategy for harnessing the capability which exists, more intensively and on a wider front.

The application of existing knowledge to the solution of neglected problems of development, especially in interdisciplinary areas with an additional socio-political dimension, often demands highly creative and innovative efforts and an application of a systems analysis capability of a high order, which is typical of any S and T

endeavour. Optimising the performance of the gobar gas plants and integrating their widespread use with the use of other sources of energy on the one hand, and with the use of chemical fertilisers on the other, is an example of such a challenging area.

Our S and T effort has to be reoriented and geared to the imperatives of development of rural areas which account for 70 per cent of the population. The tasks are manifold: the productivity of artisans and craftsmen in rural areas has to be enhanced by upgrading existing processes, tools and techniques and improving their understanding of the technological content and the often simple science underlying them; and also as a corollary, by introducing simple new processes and techniques. Optimal use has to be made of local natural resources, including agricultural wastes: agro-industries have to be developed, water supply and sanitation have to be improved, health delivery service strengthened, etc. Science must provide a new philosophy for action, enabling man, irrespective of origin, to rise to his full stature.

There is an increasing emphasis on development from below, with voluntary agencies playing an important role. Universities will, therefore, have to undertake programmes for enhancing the scientific outlook, knowledge and skills of workers in existing voluntary agencies, and training a large number of young people to provide inputs into existing or new voluntary agencies. Universities will also have to reorient some of their educational programmes, including those in technology and management, to serve the needs of decentralised development, and in general, to prepare the youth to face the challenges of development.

Developmental programmes with S and T content will have to be used for spreading scientific awareness and temper among the people, so as to enhance their absorptive capability for S and T. In doing so, there will have to be an increasing use of regional languages, so that science may be internalised by the people thereby improving the dialogue and communication between university educated scientists and ordinary people. In this way, problems from the field, or new techniques developed by ordinary people in the field, may be transmitted to the scientists for solution or for further development, and new results from laboratories will spread among the people.

During the last few years, several voluntary S and T groups have been active in the area of rural development, some of them with the backing of advanced S and T institutions. Such rural involvement of young scientists and technologists and their institutions will be promoted through appropriate budgetary support and personnel policies.

Table 1 Expenditure on R and D in relation to gross national product and population

	1968-69	1968-69	1973-74	1976-77
1 Expenditure on R and D and related S and T activities (Rs. crores)				
Central sector	27.66	109.60	199.05	361.49
State sector	1.00	11.59	24.13	37.14
Private sector	0.15	9.85	30.35	49.50
	28.81	131.44	253.53	448.13
2 GNP at current prices (Rs. crores)	12,600 (NNP)	30,293	53,695	71,047
Expd. on R and D as % of GNP	0.23	0.43	0.47	0.63
3 Total population (crores, 1 March)	42.10	52.31	58.41	62.16
Per capita expenditure on R and D (Rs.)	0.68	2.51	4.34	7.21

1 Expenditure on R and D Department of Science and Technology, Research and Development Statistics, 1976-77

2 GNP Central Statistical Organisation (*Estimates of National Income*, February 1964 and *Monthly Abstract of Statistics*, April 1979) and *Economic Survey* 1978-79, Govt of India

3 Population . Planning Commission.

The Government has decided to streamline the various schemes, agencies and organisation for helping village and small industries, by creation of District Industries Centres (DICs) which should provide a package of assistance to artisans, craftsmen and small entrepreneurs. A substantial investment will be made in this programme and it will be necessary to provide adequate S and T back-up to the DICs and to ensure a modern scientific systems analysis and management approach in their functioning.

In order to provide linkage between field problems, having an S and T content, and research laboratories, it will be necessary to create some rural S and T resource centres in the districts. These will be planned, so as to provide a two-way communication between the national laboratories/ universities and colleges, on the one hand, and field level agencies such as the District Industries Centres, Small Industries Service Institutes, Small Industries Development Corporation, Handloom and Handicraft Boards, Khadi and Village Industries Commission and Boards, and voluntary agencies. Such S and T Resources Centres will be created by strengthening voluntary S and T groups which are already working in the field, and by encouraging and supporting universities/IITs/ national laboratories to set up rural extension centres with appropriate manpower and laboratory/workshop backing. Entrepreneurs setting up testing laboratories would provide another kind of S and T back-up to the rural industries. Rural banks and co-operatives, which have a stake in a project or an area, would also be expected to help set up such rural S and T centres.

In the above context, the recent policy decision of the UGC that extension be considered as a third dimension of academic programmes in universities, equal in importance to teaching and research, represents a significant step. Apart from providing S and T back-up to various rural development programmes through S and T Resource Centres, universities and national laboratories could also help in solving the problems of small-scale industries as identified and projected by the State level R and D Committees. They could also take up specific selected industries in their neighbourhood (for example, smithy, foundry, textiles, paper, ceramics, etc), survey the production practices and try to bring about improvements in techniques, processes and products.

Over a period of time, most scientific, technological and educational institutions should be expected to devote a certain identifiable part (at least ten per cent in the first instance) of their efforts to programmes directly related to the minimum needs programme and rural development. Even high technology agencies like atomic energy and space can play an important role in this domain, as was shown by the experience with the Satellite Instruction Television Experiment. They represent a concentration not only of S and T expertise but also of a systems capability and an experience of setting up teams to handle complex projects, which can also be brought to bear on problems of rural development. In this way, S and T could provide levers of social change.

In the past, the benefits of many schemes have often not reached the target populations, and in the absence of continuous monitoring, prog-

rammes often get distorted at the implementation level, and the benefits get pre-empted by those who are already well off. It is necessary to institute a built-in mechanism for monitoring and evaluation. Teams of natural and social scientists could be organised to make an objective assessment of the impact of these programmes on the quality of life of the target population, in terms of well-defined indicators, and such assessment should form the basis for continuous upgrading/reorientation of these programmes. Pilot projects of this kind should help in evolving an integrated systems approach to problems of rural development.

Decentralised development, with emphasis on employment generation in as many sectors as possible, implies a development strategy different from that adopted by the highly industrialised countries, and correspondingly, it demands self-reliance in choice and development of technologies. Interactions between the research laboratories and the productive processes and practices around them, such as those discussed above, should help generate 'appropriate technology'. Rural technology should not be taken to mean primitive technology or technology of yesterday. A determined effort is needed to take modern science and technology to villages with a changed perspective and due de-escalation/simplification of technology so that it is brought well within the material, financial and skill resources of rural people. While searching for and improving upon such technologies, which increase employment opportunities for our people, therefore, it will be simplistic and dangerous to confine indigenous efforts to relatively simple technology for rural needs and depend on import of technology in the high technology areas. We have also to ensure an appropriate mix of small, medium and largescale technologies, in a manner consistent with our long-term interests. Many heavy industries, for example, power, steel, fertilisers and heavy chemicals, machinery and equipment, are essential for developing our rural industries. Further, 'appropriateness' itself is to be viewed as a dynamically evolving concept.

> *"Science must provide a new philosophy for action, enabling man, irrespective of origin, to rise to his full stature."*

Largescale involvement of the S and T institutes and the academic community in such programmes will call for change in the value system of the academic and S and T community,

Table 2 Industry-wise break-up of foreign collaboration approved by the Government during 1969-1978

Name of the Industry	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Metallurgical industries	6	11	10	13	11	23	19	12	7	16
Fuels	—	—	—	—	1	1	—	—	1	4
Boilers & steam generating plants	1	1	1	3	3	5	3	1	4	—
Prime movers (other than elect. generators)	1	4	—	1	—	4	—	1	1	3
Electrical equipment	19	22	52	39	55	72	53	63	67	46
Telecommunications	2	4	—	—	1	—	—	—	—	2
Transportation	17	15	16	19	31	34	15	16	18	20
Industrial machinery	18	34	32	45	54	69	50	57	74	76
Machine tools	12	6	28	19	19	14	12	19	10	20
Agricultural machinery	10	3	13	—	1	—	—	—	—	—
Earth-moving machinery	1	—	1	2	2	—	1	1	1	2
Miscellaneous mechanical & engg. industries	4	6	4	7	11	13	9	13	4	7
Commercial, office & house-hold	—	—	6	4	6	5	1	1	1	2
Medical & surgical appliances	—	1	1	2	1	4	3	1	1	1
Industrial instruments	5	3	4	3	2	6	2	4	9	9
Scientific instruments	1	—	—	1	1	—	—	1	2	2
Mathematical, surveying & drawing instruments	—	—	—	—	—	—	1	1	—	—
Fertilisers	—	1	—	—	—	—	—	—	—	—
Chemicals (other than fertilisers)	17	10	37	31	16	41	40	32	23	36
Photographic raw film and paper	—	1	—	—	—	—	—	1	1	—
Dyestuffs	—	—	1	—	—	—	1	—	—	—
Drugs & pharmaceuticals	—	3	2	1	3	—	2	1	3	2
Textiles including those dyed, printed or otherwise processed	1	1	5	2	1	5	3	2	2	2
Paper & pulp including paper products	3	1	4	5	6	6	—	2	6	4
Sugar	—	—	—	—	—	—	—	—	—	—
Fermentation industries	—	2	1	3	1	—	—	—	2	—
Food processing industries	1	—	1	—	1	2	4	2	2	2
Vegetable oil and vanaspathi	—	—	—	—	—	—	—	1	—	1
Soaps, cosmetics & toilet preparations	—	—	—	—	—	—	1	—	1	—
Rubber goods	—	8	1	6	5	12	6	4	4	7
Leather, leather goods & pickers	1	—	3	1	1	3	4	1	3	6
Glue & gelatine	—	—	2	—	1	1	2	—	—	1
Glass	1	1	4	2	6	6	2	5	5	—
Ceramics	1	2	4	4	3	5	7	7	1	6
Cement & gypsum products	—	1	1	1	1	1	2	4	3	3
Timber products	1	1	1	—	—	2	2	—	—	—
Defence industries	—	—	—	—	—	—	—	—	—	—
Cigarettes	—	—	—	—	—	—	—	—	—	—
Consultancy	3	5	1	6	1	3	5	—	2	4
Miscellaneous (non-scheduled industries)	9	35	9	35	20	20	17	23	13	24
TOTAL	136	193	246	257	266	359	271	261	268	306

with an active concern for social problems. This should show itself up through efforts to seek out problems of development in one's own vicinity, where S and T may be applied. The S and T community has to evolve its own standards of relevance and excellence, and not allow them to be distorted by international science. In particular, the career structure of discipline-based science has to be transformed, so as to encourage the involvement of scientists in nationally relevant activities, such as those pertaining to the development of rural areas. Academies and professional associations would have to play an important role in this regard. The Indian Science Congress Association has already taken some steps in this direction. On the whole, optimal use of S and T for rural development will call for social activism on the part of universities and scientific institutions. Such participatory social activism will also help bring in greater relevance into the course/training/research programmes in universities, promote scientific humanism and thereby motivate and prepare students better for undertaking the challenges of rural development in terms of knowledge, skills and attitudes.

S and T planning and implementation

Planning for S and T in relation to socio-economic objectives is a relatively new concept in India. While S and T permeate almost all areas of national activity, science and technology planning, in terms of objectives and programmes, processes and techniques to be developed and technological capabilities to be acquired, had until the Fifth Plan been mostly confined to a few scientific agencies and allied departments, in particular, agriculture, atomic energy, space, the CSIR and defence. An integrated systems approach has characterised the planning and execution of programmes in the fields of atomic energy and space: building and exploiting in-house capability, identifying and using the capacity outside R and D institutions or industry, or persuading industry to undertake fabrication of high-precision sophisticated equipment. The purposeful use of research and extension has also paid rich dividends in the field of agriculture. The Department of Electronics has been maintaining an overview of the technology needs of the rapidly growing and changing area of

Table 3 Import of technology through licences made by foreign companies in India and Indian companies set up with foreign collaboration

Year	Expenditure (Rs. crores)		No. of foreign collaborations approved each year*
	Technical knowhow	Royalty	
1969-70	13.1	5.7	135
1970-71	20.6	5.1	183
1971-72	13.9	5.9	245
1972-73	11.4	7.3	257
1973-74	14.1	6.2	265
1974-75	12.6	8.5	359
1975-76	25.6	10.5	271
1976-77	37.8	15.9	277
1977-78	NA	NA	287
1978-79	NA	NA	307

Source : Ministry of Finance, Department of Economic Affairs. (*Calendar years. NA—Not available.)

electronics, and it is hoped that this will help promote technology and industrial development in this important sector. In other sectors, S and T efforts have remained largely fragmentary and it is important to foster co-ordination and make an optimal use of complementary expertise and facilities that may exist under different laboratories/ministries and to supplement them where necessary so as to develop a total systems capability. For example, in the area of communications, the capabilities represented by the Telecommunications Research Centre and Indian Telephone Industries, as well as Electronics Corporation of India Ltd, Indian Space Research Organisation, Bharat Electronics Ltd, and Defence Research and Development Organisation will have to be harnessed for a common purpose. Chemicals (including drugs, fertilisers and pesticides) and energy represent other important areas, where co-ordinated efforts are called for.

In areas other than those represented by the major agencies, a systems approach has been missing in the ministries concerned. The S and T awareness and absorptivity for S and T inputs have, therefore, remained inadequate, and correspondingly, S and T tasks crucial for our economy have often remained unattended. Services in areas like health, housing, irrigation, power and meteorology have suffered as a consequence. Also, the country has remained dependent on and even subservient to imported technology in several areas.

The setting up of the National Committee on Science and Technology (NCST) in 1971 was an important landmark in S and T planning. In the closing years of the Fourth Plan and the early years of the Fifth Plan period, a major effort was put in by the NCST to prepare, for the first time, a comprehensive S and T Plan as an integral part of the socio-economic plan. This was in the form of "An approach to S and T Plan" brought out in 1973, and the S and T Plan (1974-79) itself brought out in 1974, based on a critical study of 24 socio-economic sectors. This S and T Plan identified gaps in the national S and T endeavour in these sectors, in relation to the objective of self-reliance and the S and T needs of the Fifth Plan. It provided a useful checklist of S and T programmes and projects that needed to be undertaken. However, in the absence of an assigned responsibility and a mechanism for fixing priorities, identifying tasks and projects and allocating resources to appropriate institutions for carrying these out, and for ensuring its implementation, monitoring and review, the NCST Plan remained largely unimplemented. An approach to a desirable mechanism could only be devised midway through the Fifth Plan when the Planning Commission started holding separate discussions on the S and T component of the Annual Plan with each economic ministry/department, with participation from the CSIR, Department of Science and Technology, Directorate-General of Technical Development, Department of Electronics and allied ministries and organisations. These have helped to create in those administrative ministries where the S and T base has been weak, a greater awareness about the S and T inputs which could further their sectoral economic objectives. As a part of this process, separate S and T budget-heads have been created in various Central Ministries, and Special Committees for Implementation of Projects (SCIP) have been set up in a few of them. As a result, S and T allocation and their utilisation in some of these sectors have shown some increase during the last two years. This process will be strengthened and streamlined during the Five-Year Plan (1978-83) by identifying/creating an effective mechanism within the Planning Commission and within the economic ministries to take responsibility for a number of inter-related functions, so that S and T planning may become an integral part of socio-economic planning. These include:

(a) creating/promoting/strengthening linkages between R and D laboratories (including those in universities and IITs) and

"... in the absence of an assigned responsibility and a mechanism for fixing priorities, identifying tasks and projects and allocating resources to appropriate institutions for carrying out the programmes and for ensuring its implementation, monitoring and review, the NCST Plan remained largely unimplemented."

the problems of rural development, including S and T back-up to organisations like KVIC, DICs, and to voluntary organisations active in the field

(b) creating/promoting/strengthening linkages between R and D laboratories and industries (cottage, smallscale, mediumscale and largescale).

(c) ensuring the requisite S and T inputs into the existing industries/services in various sectors, from the point of view of improvement of efficiency of plant/services and the quality of products, self-reliance with regard to inputs, including raw materials and intermediates, upgrading technical knowhow for keeping abreast of scientific and technical advances, waste utilisation, environmental control, etc

(d) promotion of horizontal transfer of knowhow

(e) identification of institutions (national laboratories, universities, IITs and industrial laboratories), some of which may lie in different sectors or under different ministries or privately owned, where capability to carry out S and T tasks relevant to any particular sector exists, and assigning such tasks to those institutions

(f) maintaining a comprehensive registry of foreign collaboration agreements in force in each sector, including information on the nature of the technologies acquired, the terms and scheme of acquisition, and follow-up on absorptive R and D

(g) preparation of sectoral state-of-art reports from time to time, identifying critical scientific and technological gaps, and indicating where intensified long-term basic/applied/developmental research is essential

(h) preparation of the development profile of the sector over a 10-15 year period, and in relation to the projected demands for products and services (consistent with national socio economic objectives), an assessment of the process, equipment and manpower needs, and of the technological and industrial capability that has to be built in order to meet these demands

(i) ensuring that the scale of investment in R and D for improvement of products/productivity/services, and for development of new products and processes is commensurate with the economic/service activities in the sector

(j) analysis of the prevailing organisational structure and socio-economic policies, including export-import and licensing policies, followed in various sectors, from the point of view of their impact on the demand for S and T inputs and the use of indigenous capability; possible organisational changes or changes of policy or legislation that would enable S and T, especially indigenous S and T, to play a more effective role.

(k) promoting the establishment of pilot plants and suitable design engineering consultancy services where necessary

(l) in relation to the above, definition of a strategy for optimal utilisation of indigenous capability, bilateral agreements or assistance from the United Nations Development Project and other agencies

(m) identifying technologies where we have a natural advantage and developing them intensively from the point of view of export of knowhow

(n) co-ordination to ensure that knowledge acquisition or technological capability building that may take place in various agencies/laboratories may be used in appropriate downstream field/sector (for example agriculture, flood-control, irrigation meteorology, minerals, etc)

(o) co-ordinated development and use of test facilities

"The science and technology community has to evolve its own standards of relevance and excellence, and not allow them to be distorted by international science. In particular, the current structure of discipline-based science has to be transformed so as to encourage the involvement of scientists in nationally relevant activities, such as those pertaining to the development of these areas. Academies and professional associations would have to play an important role."

Industrial research, design and development (RDD)

In more industrially advanced countries, RDD for industry is carried out largely by industries themselves, whereas in India it has remained largely a government activity. The linkages between government laboratories and industry have, in general, been weak Design engineering work to supplement the development of new processes/products has not received adequate attention till recently And in the absence of a mechanism to integrate and co-ordinate the capabilities and efforts in different institutions which may lie in different sectors or under different ministries, or under different ownership (private/public), our industrial development has largely depended on imported technology, in spite of the considerable S and T infrastructure that has been built

While strengthening the linkages and locating a nodal point for planning and co-ordination,, as discussed earlier, steps have to be taken to step up the in-house RDD by industry and to create an environment conducive to such RDD within the industry, since industrial RDD can most efficiently be carried out within the industry In-house RDD is also vital for meaningful co-operation between national laboratories and industry

While expenditure on RDD in industry has shown some growth in the last few years (Table 4), according to the latest available statistics, only about 18 per cent of the total national S and T expenditure is met by the industry, both public and private Industry has to increase its commitment to RDD, not only from the point of view of achieving self-reliance, but also from the point of view of modernising the technology of established units and improving their performance to international standards in quality, cost, relevance in the markets, and using any imported technology as a springboard for the development of competitive new technologies The magnitude of the industrial S and T endeavour has to be commensurate with the annual turnover of the industry, its growth rate, and the extent of its dependence on foreign technology, and any substantial import of technical knowhow has to be accompanied by concomitant R and D effort that is necessary in order to absorb adapt and improve upon the borrowed technology

The public sector generally had also neglected RDD until recently This lacuna is now sought to be corrected by purposeful inputs for setting up/enhancing the in-house R and D capability in various public sector undertakings The recommendations made recently by a Working Group on R and D in public-sector undertakings will form the basis of further action in this domain

There continues to be a genuine barrier against the use of indigenous technology, arising from the fact that the knowhow from an industrial R and D laboratory (whether in-house or not) does not represent 'a proven process', and therefore, the industrial enterprise accepting it takes a certain amount of risk There are two possibilities to overcome this barrier the Government itself deciding to set up industry based on the indigenous knowhow, or the Government providing some risk-insurance for the first trial of the new technology Such risk-coverage is not unknown in other

Industry	1974-75	1975-76	1976-77	1977-78
A. Expenditure on in-house R and D				(Rs. crores)
Central sector				
Communications	3.11	5.46	7.62	9.99
Heavy industry	0.89	2.23	3.45	12.71
Industrial development	—	0.42	1.66	1.90
Coal	—	—	1.25	1.26
Steel	0.22	0.61	0.71	0.97
Mines	—	0.02	0.04	0.46
Petroleum and chemicals	1.82	2.62	3.79	4.35
Total (i)	6.04	11.30	18.82	30.96
Private sector				
Drugs and pharmaceuticals	6.40	6.89	7.96	
Chemicals and fertilisers	6.05	6.42	7.86	
Electrical equipment	4.85	6.39	6.80	
Machinery and machine tools	2.72	3.46	3.83	
Transportation	1.96	2.73	2.86	
Textiles	1.52	1.92	1.94	
Dyestuffs	1.35	1.51	1.91	
Metallurgical industries	1.38	1.84	1.72	
Other industries	10.23	11.57	13.40	
Total (ii)	36.46	42.35	49.50	
Total (i+ii)	42.50	53.65	68.12	
B. Total expenditure on R and D				
Central sector	183	238	276	320
Private sector	36	42	50	
Total	219	280	326	
C. Expenditure on in-house R and D in industry as % of total expenditure on R and D				
Central sector	3.3	4.7	6.7	9.7
Total (central plus private)	19.4	19.2	20.9	

Data on central sector—Planning Commission.

Data on private sector—*Research and Development Statistics*, 1976-77, Department of Science and Technology.

countries. Recently, the National Research Development Corporation has started providing some risk-coverage by providing part of the equity, but the scale and range of its operation have to be very considerably enhanced.

Indigenous and foreign technology

The country now has a well-developed infrastructure of R and D and design engineering organisations. So the future development of industries in India must be based on indigenous technology as far as possible. Self-reliance is not a distant goal, but an attitude and a strategy towards decision-making right now. In S and T, it implies a judicious mixture of indigenous R and D and imported knowhow in such a manner that the initiative is always in our hands. It is not the acquisition of technology from abroad as such that is bad, but the way we have done it in the past has done us harm, since, among other things, often no matching indigenous R and D effort was made to get rid of the dependence on outside technology.

Technology would have to be imported in sophisticated and high-priority areas where Indian skills and technology are not adequately developed. However, even in the case of such imports, the aid would be technologically self-reliant. In such areas, the Government's preference will be for outright purchase of the best/most appropriate technology available, and then adapting such technology to the country's needs. Indian firms or corporations which are permitted to import foreign technology would be required to set up adequate R and D facilities so that the imported technology is properly adapted, assimilated and improved upon. This will be helped by associating the appropriate R and D laboratories/design engineering agencies with the import of technology. Foreign investment and acquisition of technology necessary for India's industrial development would be allowed only on such terms as are determined by the Government of India to be in the national interest. In areas where foreign technological knowhow is not needed, existing collaborations will not be renewed and foreign companies operating in such fields will have to modify their character and activities in conformity with national priorities within the framework of the Foreign Exchange Regulation Act. To guide entrepreneurs, the Government has recently issued a revised illustrative list of industries where no foreign collaboration, financial or technical, is considered necessary since indigenous technology has fully developed in those industries.

Any imported technology should be consistent with our socio-economic priorities. Therefore, the scrutiny of any proposals for technology import must include study of its possible impact on employment and consumption patterns. One simple criterion should be to leave out what we can afford to do without, as in the case of many consumer products.

Measures for containing the influence of restrictive privileges like trademarks and proprietary names, where they have hampered the normal development of R and D and its utilisation will be given careful consideration. There are areas in which expertise and technological competence relevant to a total system is divided among different R and D laboratories/industries. In such cases, a conscious effort must be made to adopt a national consortium approach, rather than invite foreign collaboration or buy equipment from abroad.

There are high-technology areas like atomic energy, space, defence, electronics and telecommunications, marine resources, etc where self-reliance has become increasingly important. There are other areas like agriculture, fertilisers and pesticides, health, coal, mining, oil exploration and exploitation, etc where the volume of production and growth of industry in the country necessitate substantial R and D inputs, which can also become cost-effective. It is necessary to define a mainstream of such sectors, and

"There are areas in which expertise and technological competence relevant to a total system is divided among different R and D laboratories/industries. In such cases, a conscious effort must be made to adopt a national consortium approach rather than invite foreign collaboration or buy equipment from abroad."

specific problem areas within them, where, as a part of a long-term planning profile, R and D resources will have to be concentrated, so that the R and D effort may be carried out on a viable scale, with well-defined time-targets. In such areas, foreign knowhow/equipment must not be imported in a manner that would cripple indigenous efforts. A policy of taking any short-term decision to buy technology from abroad, only in the context of a long-term technology perspective, becomes all the more necessary now, when we happen to have a comfortable foreign exchange position.

Given the constraints of resources, there is a need for adopting a selective approach so that fragmenting of R and D below a critical level is avoided and efforts are concentrated in areas in which (a) capability has already been built up and further development work is likely to make a larger impact; (b) the size of the industry is sufficiently large to sustain a sizable R and D effort; and (c) there is greater possibility of setting up joint ventures abroad facilitating export of technology.

Basic research universities

The main thrust of the S and T policy will be in increasing the direct relevance of national S and T efforts in relation to identified socio-economic goals and tasks. Relevance and excellence, however, in particular in basic sciences, are not mutually contradictory but can reinforce each other. Application of S and T demands, in the first instance, a strong foundation in basic sciences. Therefore, the pursuit of pure science, carried out at the highest level, where it gets its justification in terms of its relevance to the advancing frontiers, will be encouraged in all disciplines. Fundamental research is important, not only for the exciting adventure and challenges, but also because it helps to establish and maintain the tradition of intellectual inquiry, to develop an indigenous culture of science, and to create the capability for acquiring new knowledge with self-confidence. It, therefore, has an important role to play in training scientists and technologists and thus developing the S and T capability.

On the other hand, the scientific community has to review the ongoing research programmes by itself and examine their relevance, in terms of the likely impact either on the advancing frontiers or on the problems of rural/industrial/economic development, if not both. Fragmentary, peripheral research programmes will have to be discouraged by the academic community itself, within a university/laboratory and within the country as a whole, by evolving its own standards of excellence and relevance. This is very important for preserving the autonomy of universities/laboratories. Academies and professional associations could also play a very useful role in this regard.

Research in universities did not get much support until the Fifth Plan period, barring the UGC programme of Centres of Advanced Study. The situation has changed with the creation of a budget-head for research and the establishment of the Science Research Council under the UGC and the setting up of the Science and Engineering Research Committee under the Department of Science and Technology, both during the Fifth Plan period. The increasing support to research has to be purposefully utilised by the universities, to develop thrust areas and schools of research, which should compete with national laboratories and also internationally. Ph D programmes should follow from such thrust areas and should not limit the character and scope of the investigation undertaken.

Historically, a large number of laboratories and institutes, in the natural and social sciences, have been set up outside universities and with inadequate linkages with industry. Universities, as mother institutions, have suffered in the process. The concentration of expertise and facilities in these institutions has to be harnessed to improving the quality of education and promoting our socio-economic goals. While efforts will be made to establish linkages for this purpose, it is time to adopt a policy that when new institutes are contemplated they will be either within the university system or attached to the appropriate industry, unless there are explicit reasons to the contrary. However, university structures will need to be re-examined and altered in order to accommodate and foster the emergence of autonomous institutes within the university system. And while the concentration of effort in universities will continue to be in basic sciences, it will be useful for university teams to take up some goal-oriented time-bound projects so as to enhance the sense of purpose, and time- and cost-consciousness within the scientific academic system.

In our country, the mobility of scientists between scientific institutions, or between scientific institutions and users of S and T, is extremely limited. There exist various schemes to promote mobility, but they have not made much impact. More vigorous efforts to promote mobility are called for. It will also be useful for universities/laboratories to evolve a convention whereby every scientist is required to spend some period every few years at another institution, including possibly in industry.

R and D efforts at the State level

A substantial part of the responsibility for rural development falls on the State governments. The increasing investments being made in this sector have to be matched by creating/strengthening suitable S and T organisations at the State level, so that a systems approach may be brought in, and the mechanisms of implementation of various programmes are analysed and strengthened. The planning of S and T in States in an integrated manner was attempted during the Fifth Plan period when State Committees for S and T were constituted, at the instance of the NCST, in five States. Seventeen State Research Development and Design Committees have been set up under the joint auspices of the Ministry of Industrial Development and the Department of Science and Technology and these assist the Small Industries Services Institutes (SISI) established by the Small Industries Development Organisation (SIDO). These RDD Committees, usually headed by the Director of a national laboratory in the region, receive and scrutinise problems of an RDD nature which are posed by the industries in the small-scale sector. The committees have also brought out information booklets on R and D facilities available in the region. The identified problems are referred to appropriate national laboratories, engineering colleges or technical institutions for solutions. CSIR laboratories have also been specifically asked to pursue such problems of an ad-hoc, short-term or long-term nature if referred to them by the State R and D Committees. It is necessary for other States also to set up committees for S and T, as nodal points in the State Planning Boards, and for all of them to be strengthened so that they may be able to play a more dynamic role.

"The main thrust of the S and T policy will be in increasing the direct relevance to identified socio-economic goals and tasks. Relevance and excellence, particularly in basic sciences, are not mutually contradictory but can reinforce each other. The application of S and T demands, in the first instance, a strong foundation in basic sciences."

A jatra to tell people about science

IT IS the morning of 31 March 1980, in Prakasha village, Shahada taluka, Maharashtra. On an open ground near the S T bus stand one can see a rectangle of makeshift tents. 'Vidnyan Jatra '80', 'Lok Vidnyan Chalval' (People's Science Movement)—the banners outside proclaim. There are groups of people standing around—school children, Adivasi landless labourers, rich peasants—a motley crowd, all curious to enter and see this new kind of jatra.

To ordinary people, a jatra is something tremendously entertaining, an escape from everyday life into a world of colour and music. The popularity of the jatra was one reason why the People's Science Movement (PSM) decided to experiment with this form. The aim here was not to thrill, to mystify, to provide an escape. While entertaining people it should give them a fresh insight into the world around them, bring science within their reach and make them conscious of their own creative potential to change their reality.

This jatra has been organised by PSM with the co-operation of Shramik Sanghatana, a mass organisation of Adivasi landless labourers. The PSM wants to bring together the scientific intelligentsia, dissatisfied with the existing situation, on the one hand, and the masses who want change, on the other. The Shramik Sanghatana activists also feel the need for the kind of activity like PSM to widen people's horizons and help them in their struggle to change their lives. This jatra is an initial attempt to explore this possibility. How will people respond to this new experiment? To what extent will the jatra demonstrate a new way of looking at science and at their own day-to-day lives? In the midst of the atmosphere of festivity, excitement and anticipation, these questions lurk just under the surface.

A jatra on this scale involved a massive amount of preparatory work. For the past two months, volunteers of PSM in Bombay, Pune and Nanded had been planning various exhibits, visiting schools, hospitals and other institutions all over Maharashtra, getting them interested in the idea of Vidnyan Jatra and in lending their materials for it. In addition to this material, a lot of fresh material had to be prepared if each area were to be presented interestingly and coherently for a rural audience. Scientists, doctors, engineers, teachers, students, artists and full-time workers of PSM spent night after night making posters, models and writing rough commentaries to go with the exhibits. At last, about ten days before the jatra, most of the material was ready to be transported to Shahada. The collection, packing and transportation of this assorted and delicate baggage was not easy. However, slowly but surely volunteers with the materials began trickling into the Shramik Sanghatana office in Shahada.

There were about 50 people—local Adivasi youth and workers, activists of Shramik Sanghatana and PSM volunteers from Bombay, Pune, Belgaum, Nanded and Somnath. The bulk of volunteers were Adivasis, as by and large, the explanation of the various exhibits would be given by them in the local dialect, Bhilori. The training programme started off with the four areas for which materials had arrived—health, water, astronomy and natural history. Initially, we wanted to train all the volunteers in all the areas, but time was short, so after a day's general orientation and a survey of all four areas, volunteers opted for the area which they would like to work at the jatra. There followed two days of intensive discussions, demonstrations and experiments. The activists of PSM and the local volunteers threw themselves into the task of adapting the material, attempting to start from the existing conceptions of the local people and incorporating them.

In its manner of presentation (analogies from everyday life and a questioning of common misconceptions). It was a period of creativity, of learning for all those involved: for the local volunteers, an exposure to so much that was new and interesting, a fresh look at the world around them; for the PSM activists, an insight into what mass education involves, the need for it to be interwoven so closely with the experiences of people.

The jatra ground was finally ready. There was now just a day left for the jatra—time to transport the exhibits from Shahada to Prakasha. The Nehru Science Centre van arrived from Bombay with all the delicate models and specimens. The rest was sent by tractor. The work of arranging the nine different stalls had to start immediately—posters had to be put up and models assembled. The shortage of materials like bamboo, sacking and tables forced volunteers to use their resourcefulness to put up their stalls. Bedsheets, blankets and whatever available was used to cover gaps in the tarpaulin and rig up partitions.

At last, by noon on 31 March, the Jatra begins. Let us make a round of the jatra, from the beginning to the end, see and hear something of what went on in each stall and of how people reacted to what they saw.

Right at the entrance to the jatra is a section of assorted items, including some scientific toys. The commentator starts off with showing people a fresnel lens. It looks like an ordinary piece of plastic with some grooves on it. Hold it up against someone's face and see how the face looks magnified and distorted. People laugh at this. Their laughter turns to amazement when they see how it can be used to concentrate the rays of the sun at a point and set anything on fire. Why does this happen? The volunteer tries to explain. However, with the exception of literate men and children, the others don't seem to comprehend or to be interested in the explanation. This is true of some of the other things shown here—the mobius strip, the balancing clown.

Underlying scientific principles

The demonstrations are thoroughly enjoyable, but it is very difficult to get people to understand the scientific principles underlying these. At most they can draw analogies between what they see and some similar application of the principle in their daily lives. In some cases, the examples used are inappropriate. Many of the things, like the fresnel lens, are very far removed from their experience.



The volunteers at the stall on health come up with an impromptu skit about a TB patient

This raises the question of how best to combine an enjoyable experience, a connection with daily life and an understanding of the underlying scientific principle. Should this not be kept more strictly in mind when selecting items for a jatra?

People commonly believe that whatever is witnessed by the eyes is correct, the absolute truth. In the section on optical illusions they are shown examples of how their eyes can deceive them. A strip which appears emphatically bigger than another suddenly appears smaller when positions are interchanged. Straight lines appear curved, lengths are misjudged, black and white spots keep appearing in clear areas, a picture points at you from all directions—such common optical illusions startle people. They seem to enjoy the variety of ways in which their eyes can deceive them. Through startling demonstrations they become conscious of the importance of scientific methods of measurement.

The next stall deals with an area of vital importance and interest to all kinds of people in the rural areas—the problem of water. This area is presented so as to bring out the social issues involved, alongside with giving the necessary scientific information. The volunteer starts with explaining the water cycle with the help of some posters and a model. Then he talks about underground water. One model which holds people's attention demonstrates how the same ground water feeds the wells of untouchables as well as those of other castes. But misconceptions about divining water sources are missed out. The next few posters deal with deforestation. They take up questions like why forests are necessary for rainfall. Why does deforestation take place? Who benefits from it? From here we move on to irrigation—different types of irrigation, their relative costs and benefits, how irrigation facilities are distributed in Maharashtra, between various crops, between various sections of the rural population emphasising the efficient use of water.

Varying response

Different types of people respond differently to this stall. Peasants with land show great interest in the section on irrigation, participate in the discussion. Landless labourers and women are less enthused by this part. They respond very well and participate in the commentary on the earlier part when given by local activists in the local dialect. There are probably two reasons for this. The manner of presentation does not pose sharply the problem of water as faced by the landless labourer. Secondly, the stall is bare, very few posters and fewer models. This stall would have been much more interesting if it had used forms like slideshows and drama and more models.

Then follows a poster exhibition on food adulteration, obtained from the Maharashtra Government. The fact that all kinds of food can be adulterated is a new and interesting idea. People, particularly those from the middle class, want to see what they can do in their homes to detect adulteration. It would be helpful, one feels, if there are demonstrations of this. Some posters are irrelevant, for they deal with foods like butter and saffron which most people are not familiar with.

Importance of measurement

Why is measurement important? What are the different things that can be measured and how? These questions are dealt with in this exhibition of models of the Nehru Science Centre. The models need electricity



It's easier to explain with models A scientist from TIFR explains how an eclipse occurs to a group of school children

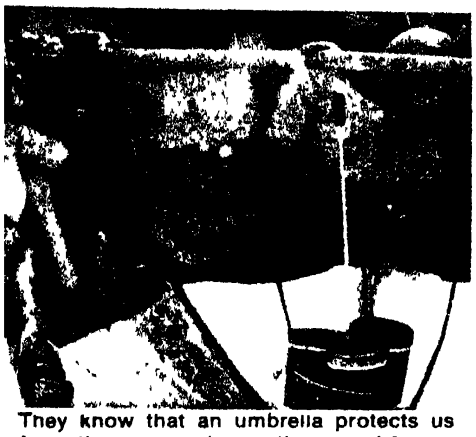
to work and most of the time there is no electricity. Most of the things presented here and the examples used are not familiar to a rural audience, with the exception of school children This exhibition can be much more effective and interesting if it were to use as its starting point the conceptions of measurements that these people have. One thing that attracted people to this section is that they can handle the models. Children, particularly, go wild with the excitement of pressing different buttons and seeing all kinds of things happening.

There are many models in the section on astronomy. The first is a model of the earth-moon-sun system where people are shown how day and night, seasons, the phases of the moon and eclipses occur. Interesting discussions take place around this model. A group of middle class women tells the volunteer—'even if what you say is true, we cannot give up the traditional practices that we observe during the eclipse.' After this is a section on the solar eclipse—a set of posters dealing with the misconceptions prevalent about the eclipse and a model which uses the principle of the pinhole camera to explain how the eclipse occurs and how it appeared on 16 February, 1980 in different parts of the country. Unfortunately, this model can be demonstrated only when there is electricity. The biggest draw in this section is the model of Skylab. People begin talking of the fears they felt when they knew Skylab was going to fall, of how some people sold all their goats and chickens and went on a last drinking binge. The remaining things in this section are a set of slides on the solar system and the telescope which everyone wants to handle. The local volunteers feel that people would have a lot of doubts and questions about this area which, though not expressed immediately, would crop up later, for many of the ideas presented challenge their basic conceptions of the universe

A solar cooker cooks rice and tea is boiled and served on another cooker in the solar energy stall. When they see rice and tea being made on a solar cooker, some people find it difficult to believe that the source of power is the sun. There must be at least electricity inside, they feel. One question is frequently asked—"How can we use this cooker in the monsoons?" Some of the cooker models, like the one made from an umbrella are cheap and simple, but there is one, made of mirrors, which is relatively difficult to make and expensive. The Adivasi landless labourers tell the volunteers, "This cooker is for the landlords, where do we have the money to make such a big one?" After considering people's reactions the volunteers feel that all the cookers demonstrated should have been made from local materials, and the costs of this, as against other forms of energy, more rigorously worked out.

How are wild animals, birds and snakes our friends? How do they live, what are their habits? What is the difference between poisonous and non-poisonous snakes? These are the main questions discussed in a section on "Our Friends". People enjoyed looking at all the specimens of animals, birds and snakes. Given this interest, the subject could have been presented in a more integrated manner, bringing out the idea of an ecosystem.

There are three sections in the stall on health — the human body, disease and a section only for women on the reproductive system, pregnancy and



They know that an umbrella protects us from the sun, and now they see how an umbrella cooks rice and dal for two persons in a few minutes

childbirth. In the first section, a skeleton, a model of the torso and specimens of soft organs are used by the volunteer to take people on a journey of their bodies. For some, it is a fascinating experience. An old Adivasi woman says, "I never knew that there were so many things inside our bodies." People are particularly struck by the soft organ specimens—a lung showing a tuberculosed cavity, a cirrhosed liver, worms in the intestine. Some of them said after this they would stop smoking and drinking.

The next section on diseases has a series of posters on TB, diarrhoea, scabies, malaria and leprosy. However, after having already spent three hours going from stall to stall, people are tired and not ready to assimilate new information unless presented very strikingly. So, on the spot, the volunteers improvise a play about a TB patient which is quite successful The TB patient's wife is played by an Adivasi volunteer with a flair for drama and a big moustache. The moustached wife keeps people in splits of laughter, at the same time ensuring a more objective response on their part to the drama. Enthused by the success of their play, by the last day the volunteers decided to put the same story into an action song in Bhilori and to get the audience to sing.

For the women, the next section is the most interesting part of the whole jatra The male and female reproductive systems, menstruation, conception, pregnancy, childbirth, abortion and family planning are discussed in this section. A serious attempt is made to look into this area from a woman's point of view, to get women to think and talk about their own conceptions of their body and its reproductive functions, to debunk certain myths about menstruation and pregnancy. The reactions of women are quite intense. Some feel that this area should not be discussed so openly. Others, particularly those active in mass struggles, feel that they have gained a lot from this section. For many of them, it is the first time they are able to discuss such issues in a group without any sense of shame or embarrassment.

Godmen and miracles

The stall dealing with superstitions and godmen is by far the most popular one in the jatra. It has a series of posters dealing with questions of belief in god and blind faith in godmen from a scientific, rationalist point of view. However, more than the posters, it is the 'miracles' performed by a 'godman', one of our volunteers, that attracts people to this stall. They watch fascinated as he draws drops of water from his head and blood from his fingertips, sets paper on fire without using matches, produces an egg from his empty hat, all the time invoking the gods to help him perform these feats. Some people spontaneously give him money. However, after he is challenged and debunked by a member of the audience, again one of our volunteers, they demand their money back!



The anatomy of miracles An activist from Nanded and a local activist played the part of the godman in a very popular stall on godmen This is the Nanded godman putting across a point

On the last night of the jatra, a street play on the same subject is put up. A woman is 'possessed' and she is being taken in a procession down the village street to a guru who will drive away the evil spirit. The guru is challenged by a rationalist and there is a confrontation between them. Crowds gather around to watch this situation. They take sides. Those who have been to the jatra and have seen the godman there are quite sceptical of the powers of the guru to cure the woman. Of all the sections in the jatra, this one seems to have the most powerful impact, at least in terms of immediate changes in attitudes and perceptions.

Every night, after the jatra closes, there is a programme of science films from the Nehru Science Centre. Films on the universe, astronomy, life under the sea, the history of the rocket, are seen with rapt attention by large audiences. The original English commentary is replaced extempore by a Marathi one by a member of the Nehru Science Centre team, which tries to make the subject interesting and relevant for a rural audience.

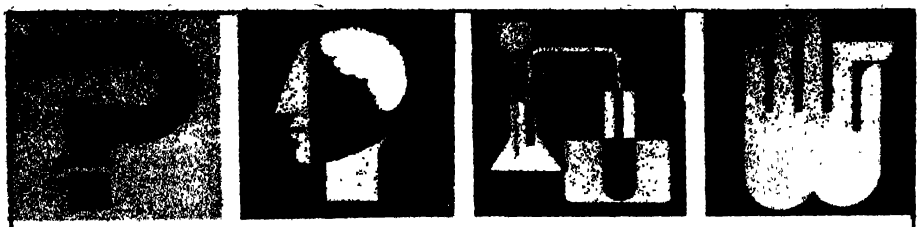
Altogether, about 7000 people attended the jatra. What were people's immediate reactions? When questioned, they would say that it was very good, that they liked everything. Some people, particularly the women, seemed somewhat dazed by the amount of new information they had been exposed to, and were unable to absorb it all. The things they remembered and talked about after the jatra were those which were in some way linked to their experiences and presented in a visually striking manner—a model, a specimen, a drama.

Now that the jatra is over and people have gone back to their daily lives, the local volunteers are trying to find out the impact of this jatra on people's perceptions. Do they still remember and talk about the things they saw? Has it in any way changed their misconceptions? Would they like future programmes of this type? A jatra like this can be only a starting point, a spark that kindles interest and facilitates an educational process, the stirrings of a popular movement.

This jatra was PSM's first experience of mass education on such a scale. Mistakes were made, in the presentation of areas and selection of models, in the actual organisation of the jatra. At times there was inefficiency and wastage and our organisational weakness showed up. But all in all, it has been a tremendous educative experience. It has brought to us a realisation of our own potential, a realisation of the curiosity and desire, however hesitantly expressed, of common people to know more about the world around them and to make sense of it.

ANJALI MONTEIRO

Miss Monteiro is working on an Adult Education Project at Xavier's Institute of Communications, Bombay, as audio-visual producer. She is a member of the Science Education Group, Bombay.



The method of science 7

Text©P M Bhargava
Design Feroze Chandra

Science has no "high priests"

No scientist can insist that whatever he says must be accepted without questioning, that is, entirely on the basis of faith in him

There has probably never been a scientist—including the most eminent ones, such as Newton, Einstein, Raman, Crick or Monod—who has not been questioned and shown to be wrong sometime or the other.

Science, therefore, does not accept that "godmen" exist who have special powers that cannot be understood by other men, and whose statements and actions must, therefore, be accepted by others without questioning.

New discoveries in science often disprove existing scientific beliefs

A discovery in science often disproves a part or whole of an existing scientific fact or generalisation.

Here are some examples:

1. Estimates in the past of such a simple parameter as the density of air significantly differed from the value accepted today.

Year	Name of the experimenter	Estimated specific gravity of air
1600	Galileo	0 0025
1642	Descartes	0 0067
	Mersenne	0.0007
1659	–	0 0011
Today	—	0 0013

Obviously, not all the above values can be correct

2. Proteins are constituents of our diet which are essential for us to survive, grow and be healthy. It is, therefore, important to know how much protein we need to consume everyday. Estimates of the daily protein requirements of an average, normal adult male have, however, changed drastically over the years:

Year	Estimated daily protein requirements
1881	145 grams
1936	65 grams
1965	46 grams

3. Einstein's theory of relativity enunciated in 1905 disproved several beliefs held by scientists. Until then the following statements, for example, were generally held to be true by scientists.

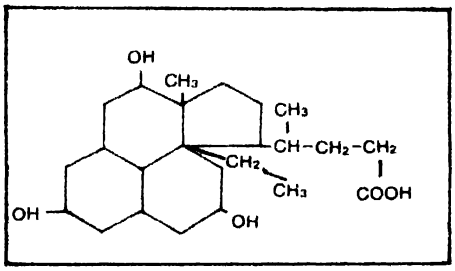
* The mass of an object does not depend on the speed at which the object is travelling.
* Mass and energy are not inter-convertible.
* Speed of light in free space depends on the motion of the light source and the observer.

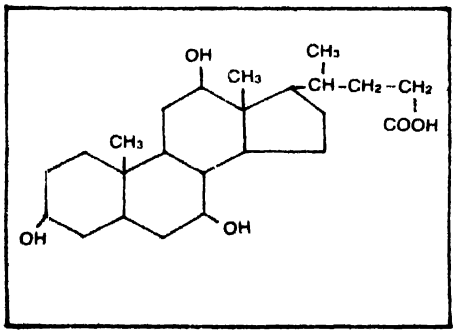
Today, we know that these statements are incorrect.

4. At least two Nobel prizes were awarded for discoveries which were later partially disproved.

* In 1927, Heinrich Wieland received the Nobel prize for chemistry for discovering the structure of cholic acid. Cholic acid is the parent substance from which are derived a large number of important chemical compounds, such as cholesterol (an excess of this compound in the body is correlated with heart disease). Within a year of the award, Wieland's structure of cholic acid was disproved.

* In 1959, S Ochoa and A. Kornberg received the Nobel prize for physiology and medicine for the discovery of enzymes. Enzymes are biological catalysts which carry out the synthesis of nucleic acids—the chemical substances responsible for heredity. Later, it turned out that neither of the two enzymes discovered by Ochoa and Kornberg was responsible for the synthesis of nucleic acids in living systems. Ochoa discovered the enzyme polynucleotide phosphorylase which was believed, at the time of the discovery, to synthesise RNA (ribonucleic acid), an important substance present in all cells. A few years later it was found that the enzyme which actually synthesises RNA in the cells, is a different one: it is called RNA polymerase Kornberg discovered the enzyme DNA polymerase I which was believed, at the time of the discovery, to synthesise DNA (deoxyribonucleic acid), the genetic material. In the early 1970s, it was found that the enzyme which actually synthesises DNA in the cells is a different one. it is called DNA polymerase III.





The structure of cholic acid proposed by Wieland (top) and the correct structure of cholic acid (above)

5. In 1962, E C.G. Sudarshan, an Indian scientist, showed that faster-than-light particles (which he called "tachyons") may exist. This would seem to go against what has so far been regarded as one of the fundamental laws of physics: that nothing can travel faster than light.

6. Till recently, it was widely believed that the major nutritional problem in the developing countries such as India was the problem of protein deficiency—that is, people did not eat enough protein. Recent work has disproved this theory and shown that the major problem is a deficiency of protein as well as the deficiency of the other major energy-producing constituents of our diet. In other words, people are not getting enough food to eat.

Enjoy
Milkafé
the delicious creamy coffee



that just needs water!

Pure coffee + full cream milk + sugar.



Just mix in chilled water for refreshing cold coffee...or in steaming water for stimulating hot coffee.

Available in Northern and Western Regions

A product of INDODAN MILK PRODUCTS LTD.
makers of INDANA DAIRY PRODUCTS

Milkafé–the readimix coffee

Grgnt. M 2 80

Foam sweet foam

When comparing one lather with another, shavers go by vague impressions and uneducated guesses. Isn't there a way to measure lathering ability?

There is. It's known in the industry as the Ross Miles Foam Test. We



pitted Lakmé Shaving Cream against two leading brands. Lakmé notched 25.8% and 15.4% higher readings for lather abundance. With a tighter concentration of bubbles, greater staying power, superior tenderising and lubricating action.

All in all, a helluva shave. Try it. And follow through with Lakmé After Shave Lotion. A fitting finish to a job well done.

Lakmé Shaving Cream & After Shave Lotion



Lakmé

deCunha-L-87

... what makes the night sky dark?

If this be true, and if they are suns having the same nature as our sun, why do not these suns collectively out-distance our sun in brilliance?
—Johannes Kepler (1610)

THIS seemingly simple question is not easy to answer without a knowledge of the structure of the universe at large. The universe is vast and contains countless twinkling stars and galaxies. We may fancy that it is bound or unbound. Both the bound and unbound pictures of the universe lead to serious contradictions which astronomers have been trying to resolve for over 300 years now.

Kepler, in the 16th century, believed in a finite universe bounded by a cosmic edge. According to him, a finite number of stars are embedded in space separated by ample distances. The line of sight in any direction is less frequently intercepted by a star than by the dark celestial vault. Therefore, for Kepler, the dark night sky was not a puzzle. He asserted that the night sky is dark because only a finite number of stars are stuck to it!

Thomas Digges, before Kepler, conjectured an endless static universe populated by an infinite number of stars. Kepler rejected that picture of the universe on the plea that if one accepts such a model, the night sky should be ablaze everywhere with a brilliance equal to the sun's disc, for, in such a universe the line of sight in any direction should cross a star.

To convince ourselves that Digges's picture leads to a bright night sky, let us make a simple calculation. We assume uniform distribution of stars in the infinite universe. Such a distribution is reasonable. With the earth as centre (any other point will be as good), we shall divide the universe into concentric spheres whose radii increase by equal amount from one sphere to the next. The stellar density being the same everywhere, the number of stars in each spherical shell *increases* as the square of the distance. Also, the light intensity from any star *decreases* inversely as the square of the distance. So the total amount of light received at the point of observation from stars in any one shell remains the same. Since there is an infinite number of shells, the light intensity at the observer's position adds up to infinity. Therefore, Digges's universe should present a celestial vault resplendent with infinite brightness. Even if we take into account the absorption of light in the stellar matter this conclusion is scarcely affected. But the sky is dark at night.

Edmund Halley, a century after Kepler, supported the infinite universe picture. He sought to explain the dark sky paradox by adopting a different law for the decrease in intensity of light from more distant stars. He argued that the intensity of light from more distant stars would decrease much faster than the intensity of light from the nearer stars. Newton was the president of the Royal Society before which Halley expounded his hypothesis. Strangely his arguments seem to have escaped Newton's attention.

J. P. Loys de Cheseaux, in 1744, attributed the darkness of the night sky to the absorption of light by a gaseous fluid distributed throughout space. H. Wilhelm M. Olbers, in 1823, offered a similar explanation to account for the apparent contradiction between the infinite sea of stars which should make the sky glow like the sun's disc and the darkness of the night sky. Since then the puzzling dark night sky came to be known as "Olbers Paradox". The solution proposed by Cheseaux and Olbers nevertheless, fails because as William Herschel in 1848 showed, the absorbing gas is heated up and eventually emits as much radiation as it receives.



Kepler

Attempts were then made to resolve the paradox by presenting a universe which is unbounded but finite. The universe, for instance, which is likened to the surface of a balloon is finite and possesses no edge. The balloon picture can also be extended to include the expansion of the universe. But here we shall limit our consideration to a static picture. We then see a continuous distribution of stars which presents a scene not different from Digges's universe. Thus a finite but unbounded universe will also not resolve the contradication. The sky should be as bright as the sun everywhere, day and night.

The conclusion that the sky should be as bright as the sun is based on pre-relativity physics and astronomy. Twentieth century science offers two solutions to resolve the paradox. Each of these solutions has its own merit to commend acceptance. We shall consider them in sequence.

The first of the solutions is contained in Hubble's discovery (1929) of the uniform expansion of the universe. The galaxies which constitute the universe are moving away from one another with speeds proportional to their relative distances. Due to the Doppler effect (see SCIENCE TODAY, February 1976, p. 60), the light coming from the more distant galaxies experience a shift towards lower frequency. Coupled with the decrease of light intensity inversely as the square of the distance, this effect weakens the light from stars in the distant galaxies. Hence, the more effective ones will only be the nearer stars. Because of the finite number of these stars the celestial vault is lit up sparingly. As a consequence, the night sky looks dark.

The second solution stems from the finite luminous lifetime of the stars and their sparing distribution in space (Edmand Harrison, 1974). The average density of matter in the universe is equal to one hydrogen atom per cubic metre. If all the matter in the universe is converted into blackbody radiation, that radiation would have a temperature of 20K. But the surface temperature of the sun is 6,000K. Therefore, we see that the universe does not contain enough mass energy to create a bright sky. To make the whole sky shine like the sun's disc, the density of matter in the universe should be 1.7×10^{-14} kg per cubic metre. For a more convincing way of resolving the paradox we might follow a better analysis. The average distance between the stars in the universe is 0.1 light year. Their luminous lifetime is, on the average, 10^{10} years. It means then the stars which are farther away from us by distances greater than 10^{10} light years are not effective in contributing light intensity at the point of observation. Therefore, even if we consider Digges's infinite universe with an infinite number of stars, we see only a finite number of stars confined to a finite region of space contributing light. The infinite universe becomes equivalent to a finite universe as far as the total effective light output is considered. Here again we reach the same conclusion. There are fewer stars to light up the celestial vault and so the sky at night looks dark. The sky can, however, become as bright as the sun if the stellar density increases by a factor of 10^{13}.

Kepler was right. The stellar density is too small to fill the dark void. The 20th century answers support Kepler, although they are conceived from two different standpoints. Perhaps the answers themselves are complementary.

H. SANJEEVIAH

Dr. Sanjeeviah is Reader in Physics, University of Mysore at Manasagangotri.

A 2500-year old Secret Egyptian Formula that Unlocks the Mysteries of Wealth and Success... The Power Within

A secret formula unwritten until now

Remember the ancient Egyptians and their fabulous wealth? Even today the tombs of the Pharoahs yield spectacular quantities of gold silver diamonds and other precious stones How did they ever amass these incredible riches? The answer is contained in this startlingly powerful 200 page secret formula that AUTOMATICALLY GETS YOU ANYTHING YOU WANT IN LIFE! Money fame success happiness love power they re all yours for the asking providing you know how to work the formula.

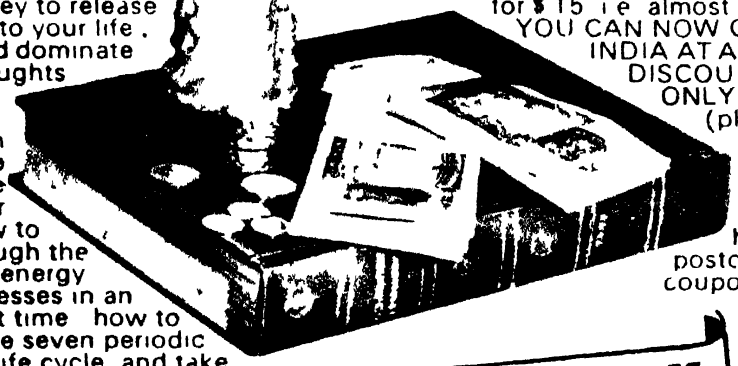
Guaranteed to shake your world

In infinite painstaking detail it tells you how to turn the key to release a flood of riches into your life . how to read control and dominate other people's thoughts actions and attitudes how to gain the power used down through the centuries to change and control your own destiny how to heal people through the power of psychic energy and rid yourself of illnesses in an amazingly short time how to understand the seven periodic movements of your life cycle and take full advantage of them all these as well as many other closely guarded ancient secrets hitherto kept under a veil of silence and superstition can now be yours!

Guaranteed to work or you pay nothing

How is it possible that nobody s ever heard of this incredible formula? Don't worry lots of people have Only they ve kept silent about it for obvious reasons King Artaxerxes of Egypt used this formula to attain the pinnacle of power. Much later, Napoleon did the same

Today. Rockefeller Onassis Jean Paul Getty Howard Hughes—all tremendously successful people who started out very poor in life they are just a few of the people who have used the power of this formula with staggering results NOW YOU CAN TOO! This is the chance you ve been waiting for! This 200 page formula is being sold abroad for $ 15 i e almost Rs 120/ YOU CAN NOW GET IT IN INDIA AT A SPECIAL DISCOUNT PRICE OF ONLY Rs 43/ (plus Rs 4/- for packing and postage). Stocks are limited So hurry, drop us a postcard or mail the coupon below fast!



MONEY BACK GUARANTEE OFFER

Now Rs.43/- only



Institute of Human Dynamics (Dept ST 7)
3/305, Navjivan Society,
Lamington Road, Bombay 400008

Please rush me "The Power Within"—the 200 – page Secret Formula of Success under your one week guarantee period I understand if I am not satisfied I can return it within a week to get my money back (less packing & postage)

I will pay postman Rs 47/ (Including Rs 4/- for packing & postage) St- 7

Name----------

Address ----------

Save Rs 5/-. Please tick
☐ Cheque/I P O for Rs 42/- enclosed.
☐ M.O for Rs. 42/- sent. (Same 7-day money back privilege)

Institute of Human Dynamics is a division of Business Development Associates
Cheques/I P O.'s/M O 's should be in favour of Business Development Associates.

MAIL NO-RISK COUPON TODAY

Disasters: facing the eighties

M. S. Swaminathan

FAMINES AND other natural calamities are known throughout the Indian history. But it was in the late 19th century that a definite policy about the role of the Government in combating famines and scarcity conditions evolved and ultimately culminated in the adoption of Famine Codes by different provincial governments. The process began with the appointment of Col. Baird Smith by the Government of India to look into the causes of the 1860-61 famine in the North-West Province and suggest remedial measures. Interestingly enough, he defined Indian famines as *"rather famines of work than of food; for, when work can be had and paid for, food is always forthcoming"*

The Orissa famine of 1865-67 was the worst in the 19th century. It led to the appointment of the Orissa Famine Commission under the chairmanship of George Campbell. The Commission laid stress on improving the system of land tenure, construction of canals, streamlining postal communications and compiling correct figures of rainfall data and other agricultural statistics. Though it was the first detailed and critical report on Indian famines, not much attention was paid to its recommendations.

The Famine Inquiry Commission under Gen. R. Strachey in May 1878 laid down the main principles of famine relief administration in India. One of its major recommendations related to setting up a separate department for the administration of famine relief. Subsequently, there were other commissions which updated and widened the scope of the Provincial Famine Code issued in 1883.

After independence, the system of financing relief expenditure following natural calamities was further streamlined and the relative responsibility between the Centre and the State has been defined periodically by the recommendations of the successive Finance Commissions. Steps have been initiated to prepare a Model Relief Manual. The attention of the Government of India and the State governments has also been increasingly drawn to the need for Disaster Preparedness Programmes as distinct from post-disaster relief operations. Contingency plans being drawn up today recognise that even a little preparedness is worth more than a big relief programme.

Programmes relating to disaster preparedness and management fall under two broad groups: (a) relief and rehabilitation measures in the most seriously affected areas (MSA districts), and (b) stabilisation of crop under favourable weather conditions. In the MSA districts, the action programme should aim at providing water, work, food, fodder and fuel to people. The National Food Security System, comprising the following four elements, would help us to ensure that the basic minimum needs of the affected human and farm animal population are met:

(i) ecological security, that is, protecting the land, water, flora and fauna resources in such a manner that sustained agricultural advance is possible;

(ii) technological security which can help to increase and stabilise



NANA SHIVALKAR

production under varying agro-ecological conditions;

(iii) public policy packages which can stimulate both production and consumption, particularly by the small and marginal farmers on the one hand, and urban and rural consumers living below the poverty line on the other; and

(iv) safe storage of grains and their effective distribution.

The results of the "Food for Work Programme" as well as other employment generation schemes indicate that we will be able to minimise acute human distress provided we continue the policy of maintaining reasonable grain reserves.

Efforts in the area of establishing a drinking water security system in the country need to be stepped up. Recently, the Planning Commission has decided that investment in drinking water supply programmes should be of an order such that all the villages of India have safe drinking water by 1985. Another innovative programme which has recently been approved relates to the establishment of groundwater sanctuaries in the chronically drought-prone areas. A groundwater sanctuary is a suitable area or locality from which groundwater would be extracted only during critical dry months. The implementation of this concept is yet to be planned.

While some typical conditions can easily be foreseen, it is likely that the design of the sanctuary will have to be practically on a village-by-village basis.

In the case of farm animals, it will be necessary to establish cattle camps where there is adequate drinking water, as was done in Maharashtra during the severe drought year of 1972-73. Available cellulosic materials such as straw and sugarcane bagasse can be enriched with urea and molasses to form a complete food.

The second component of the strategy can be achieved in the long run by increasing the area under irrigation and immediately by the adoption of scientific approaches to land and water use. A suitable action plan will have to be developed in all areas where there is adequate soil moisture for the survival of the crop. In such areas, programmes for (a) popularisation of crop life-saving techniques, and (b) introduction of alternative cropping patterns depending on the behaviour of the monsoon, will have to be kept ready. To enable farmers to adopt alternative cropping strategies, reserve stocks of seeds of suitable crops and varieties need to be maintained. Seed and fertiliser reserves are essential for the security of crop production, just as grain reserves are necessary for food security. The Rajendra Prasad Memorial Lecture of the Indian Society of Agricultural Statistics, entitled "Can we face severe drought again without food imports?" (which the author had delivered in 1972), had given a detailed programme for promoting greater stability of crop production. For example, in areas where it becomes late to sow *jowar* it should be possible to take a pulse crop or bajra or any other short-duration crop. In implementing such a mid-season correction in crop planning, it will be necessary to promote community endeavour in land and water management in a watershed community. Therefore, the social engineering aspects of implementation will have to receive as much attention as the extension and input supply programmes. For promoting the average yield of crops in all irrigated areas larger quantities of fertiliser can be applied.

Fortunately, we have a large untapped irrigation potential. It has been estimated that about 113.5 million hectares can be ultimately irrigated through appropriate major, medium and minor irrigation programmes. In addition, it should be possible to bring more areas under irrigation through inter-basin transfer of river water which would have otherwise gone to the sea. This programme of linking some of the river systems is now receiving careful consideration. And when desalination becomes economically viable, it should be possible to pump sea water to some of the rain shadow regions on the coast.

In a vast country like India with different climatic conditions, it is natural that one region or the other is affected by calamities like cyclones, floods and drought. In their wake follow destruction and famines.

But human ingenuity and endeavour can convert every calamity into an opportunity for progress. Through concurrent advances in weather forecasting and disaster preparedness, we can insulate our people from the misery caused by drought and floods, and cyclones and hail-storms to a much greater extent now than was possible about a decade ago.

Dr Swaminathan is Member of the Planning Commission, was till recently Director-General of the Indian Council of Agricultural Research

Quakes, floods and cyclones

P. K. Das

Nearly 60,000 people are killed and three million injured or left homeless every year by natural disasters. Can new developments in science alleviate the misery?

A SEVERE cyclonic storm struck the coast of Bangladesh near Chittagong towards the end of 1970, and took 200,000 lives. Similar disasters struck the east coast of India in 1977 and in 1979. Apart from tropical cyclones, the poor monsoon of 1979, accompanied by drought, was believed to be one of the worst ever over India. Many parts of northern India had a rainfall deficiency of 25 per cent or more. The annual foodgrains production dropped by nearly ten per cent.

Natural disasters have attracted our attention not only by their awesome destruction, but also by their impact on the world economy. The drought over Europe in 1976, for example, brought about widespread dislocation in the price of commodities. Over the northern and eastern parts of the United States, the winters of 1976-77 and 1977-78 were the worst of their kind in 200 years and many industries had to be closed down when the temperature dropped. Cold waves in Brazil in 1975 led to a doubling in the price of coffee. The severe drought over the Sahel region of Africa during 1968-73 caused widespread devastation and suffering.

Disasters in earlier decades have led us to believe they were caused by climatic deviations. The drought over the United States in the 1930s provides an example. A climatic deviation is a large departure from the normal expectation of precipitation, or other meteorological variables. Some of the worst droughts have been attributed to ecological imbalances caused by overgrazing by cattle, or agricultural overuse. Although this might be a cause for desertification in some parts of the world, the major



Earthquake damage like this can be avoided by making structures earthquake-resistant The main philosophy behind earthquake-resistant design is to estimate the likely extent of seismic risk A safety factor for this purpose is based on an estimate of (i) the intensity of future earthquakes (ii) the location of fault zones and (iii) the design of the structure Engineers often subject model structures to severe vibrations in a laboratory The Indian Standards Institution (ISI) has drawn up guidelines for the design of earthquake resistant structures Though quake proofing could increase the cost of residential buildings by as much as 20 per cent it is worthwhile in regions which are vulnerable to quakes

droughts seem to be associated with departures from the normal rain in the region What changes in the atmosphere are responsible for this is not clear Nor do we know whether these climatic changes are self-sustained or are affected by human activity

The magnitude of any disaster in the coming decade is likely to be different This is because the total resources of the earth are limited The tremendous growth of population further aggravates the situation The margin of self sufficiency in food and resources is small In a country with strained resources, there will be very little to fall back on in the event of a disaster

What are the prospects for the eighties? Have the developments in science led us to anticipate some of the catastrophic events?

Natural disaster categories

On an average, nearly 60,000 are killed and three million are injured or left homeless every year in the world Of these, 50,000 lives are claimed by typhoons, cyclones and hurricanes which are really different names for the same disaster The other major killers are earthquakes and floods These figures provide an estimate of the possible casualties in the coming decade There is no reason to expect a sudden or large increase in the number of natural disasters in the coming decade By planning education, better surveillance and prediction, the figures could, in fact, be substantially reduced. A case of interest concerns the cyclones which hit Andhra Pradesh in 1977 and 1979 In 1977 the casualties were nearly 10 000 but in 1979 the figure was only about one tenth

Of greatest concern to India are earthquakes, tropical cyclones flood and droughts

Earthquakes

An earthquake is a sudden release of energy accumulated in rocks from tectonic processes When the internal stresses of compression exceed the mechanical strength of rocks, a violent rupture occurs and seismic waves are generated The main shock is often preceded by a number of preliminary tremors After the main shock, minor tremors of decreasing intensity occur at increasing intervals and the earth's surface recovers its equilibrium after a series of convulsive movements

The most earthquake-prone area in India is in the north-east Many earthquakes have occurred in this region The earthquake of 15 August, 1950 was one of the most intense in the world Fortunately, the worst-hit area was sparsely populated and so the toll was not high Earthquakes in this region occur along the Himalayan faults to the north of the Brahmaputra and along the Burmese mountains to the east These faults are still active

The real problem in earthquake prediction is to be able to indicate in advance the location, approximate data and the magnitude of an earthquake (SCIENCE TODAY February 1974 p 13) An interesting case of prediction was reported in the Hicheng area of China in 1975 Predictions were made some five to six hours before the heaviest shocks based on the observations of water levels in deep wells the presence of a rare radioactive gas (radon) in water, foreshocks and the unusual behaviour of animals (SCIENCE TODAY June 1976 p 26) Extensive research programmes are in progress in several countries, especially in Japan, USA, USSR, China and India to develop a scientific basis for earthquake prediction The techniques are based on monitoring stress characteristics in rocks, the frequency of small shocks, changes in the turbidity, temperature and level of water in deep wells, variations of the earth's magnetic field

Table 1

Toll of natural disasters between 1900 and 1976

	Killed	Injured or homeless
Earthquakes	2 602 165	28 894 655
Volcanic eruptions	128,058	137 931
Floods	1 287 615	175 220 230
Landslides	3,006	44 673
Avalanches	3,059	150
Cyclones	434 894	17,648 463
Hurricanes	18 513	1 197 535
Typhoons	34 103	5 437 054
Storms	7,110	432,611
Tornadoes	1 195	342,459
Total	4 579 748	382 565 [illegible]

Compiled by the United Nations (1979) The table does not include figures for drought In the case of drought the emphasis is more on economic consequences than on fatalities In India, casualty figures for all catastrophic events are difficult to come by Estimated casualties due to earthquakes between 1900 and 1970 were around 28 000 But this figure is surpassed by tropical cyclones which led to 26 300 fatal casualties in a 17 year period from 1961 to 1977 Floods rank next to tropical cyclones In the last two decades on an average, there have been 750 deaths per year because of floods

Table II(a)
Frequency of tropical cyclone formation
Northern hemisphere

Approximate period	Average number per year				
	North-west Pacific (1947-70)	North-east Pacific (1964 73)	North-west Atlantic (1934-63)	Northern Indian Ocean	
				Bay of Bengal (1891 1960)	Arabian Sea (1891-1960)
January	0.5			06	03
February	0 3		0 1	01	0
March	0 5			06	0
April	0 7			26	07
May	1 3	0 3	0.2	.40	19
June	2 3	1 6	0 5	49	19
July	4 2	3 2	0 7	55	04
August	5 8	3 8	2 3	36	01
September	6 7	2 8	3 4	39	06
October	4 4	1 5	2 0	76	24
November	3 4	0 3	0.3	.80	30
December	1.9		0 1	37	04
Total	31 5	13 5	9 6	4 5[1]	1 17

and the unusual behaviour of animals

The reason for monitoring these features is to detect the propagation of seismic waves in the earth's interior These waves, caused by geophysical stresses in the earth's interior, propagate with a speed of 6 to 10 km per second When the earth's interior is unable to withstand the cumulative effect of internal stress patterns important changes take place in the physical characteristics of seismic waves Seismologists detect these changes by carefully monitoring the physical properties of the soil and the underlying rocks The electrical resistivity of rocks, for example usually decreases before an earthquake occurs Similarly, changes occur in the magnetic properties of the earth's crust, which could be detected by precision magnetometers

Opinions differ, but the general view is that it is not yet possible to establish a really operational system of prediction There is a danger of raising too many false alarms, too

If we consider earthquakes which either equalled or exceeded a magnitude of 7 5 on the Richter scale, then the major earthquakes in Assam occurred in 1869, 1897, 1918, 1931, and 1950 This suggests a gap varying from 13 to 28 years, between the major earthquakes Since the last one occurred in 1950, the next one over this area is probably round the corner But there is no regularity in the frequency of Assam earthquakes All that could be said is that this area is under considerable stress, and a rupture in the coming decade may be possible

Tropical cyclones

Statistics indicate that some areas are much more vulnerable to tropical cyclones than others For example, six tropical cyclones may be expected on an average over the north west Pacific in September For the Bay of Bengal, the worst months are October and November. The frequency of cyclones, one per year, over the Bay of Bengal, is roughly four times that over the Arabian Sea

However, a comparison on the basis of frequency alone could be misleading, because it would be unwise to infer that the risk of disaster in a relatively low-frequency area is less important than in a higher-frequency area

Preventive measures are comparatively easy for tropical cyclones than earthquakes because the path of tropical cyclones can be monitored with greater detail Normally, three devices are used to track the path of a tropical cyclone geostationary or polar orbiting satellites, coastal radar, and aerial surveillance With the forthcoming Indian National Geostationary Satellite (INSAT) it is reasonable to expect that cyclone surveillance will be considerably improved over India in the 1980s

A geostationary satellite rotates round the earth with the same orbital speed as that of the earth Limited regions of the earth thus appear to remain stationary beneath the cameras of the satellite In the event of a tropical cyclone developing over the Bay of Bengal, for example, it should be possible to obtain the structure of clouds generated by the cyclone every half an hour Meteorologists would then be able to monitor the path of the cyclone and thereby improve their early warning system Modern satellites can view the

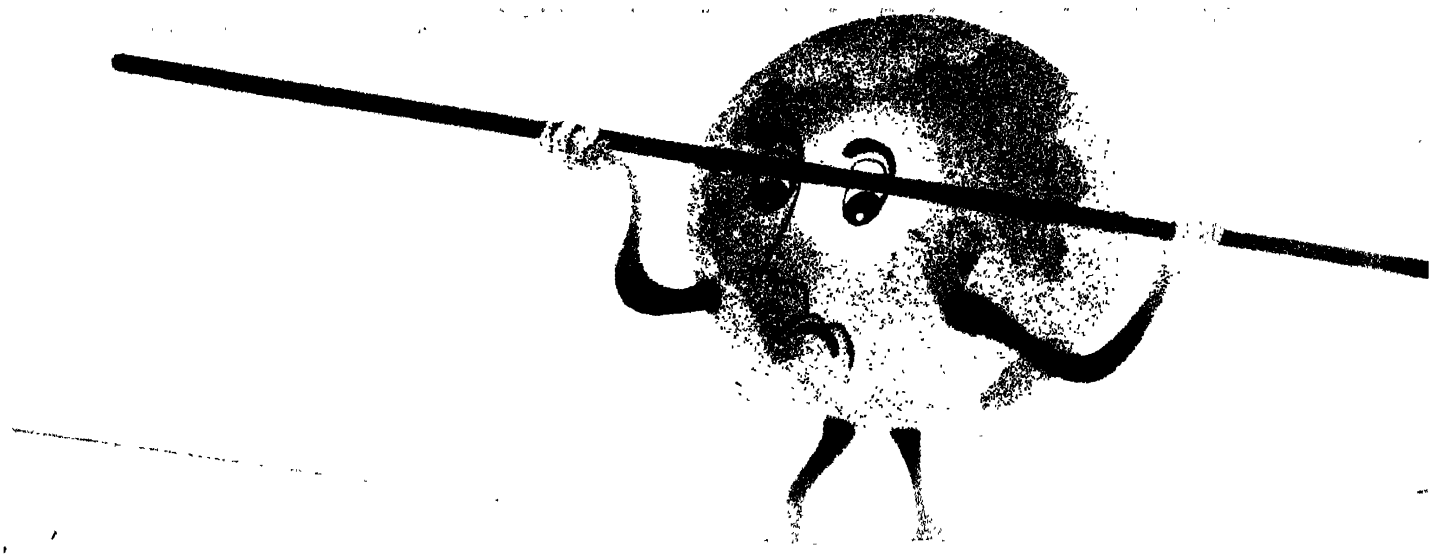
Table II(b)
Frequency of tropical cyclone formation
Southerr hemisphere

Approximate period	Average number per year		
	Southern Indian Ocean (1963 74)	South Pacific (1950 69)	
		105°E 135°E†	135°E 165°E
July			
August	0 3		0
September	0 2		
October	0 3		
November	0 6	0 1	0 3
December	2 2	0 5	0 8
January	3 3	1 5	1 6
February	2 9	1 6	1 3
March	1 5	1 3	1 3
April	0.6	0 4	0 8
May	0.3	0 1	0 2
June			0 2
Total	12.2	4 2*	5 5*

† Off north-west Australian coast

* Totals are less than the sum of the monthly values because a cyclone was counted twice if it persisted from one month to the next

Reproduced from a compilation made by the World Meteorological Organisation (1976)



movement of clouds with great precision and resolution. Thus, it is possible to derive the strength and direction of winds over the lower and upper atmosphere by tracking the movement of clouds.

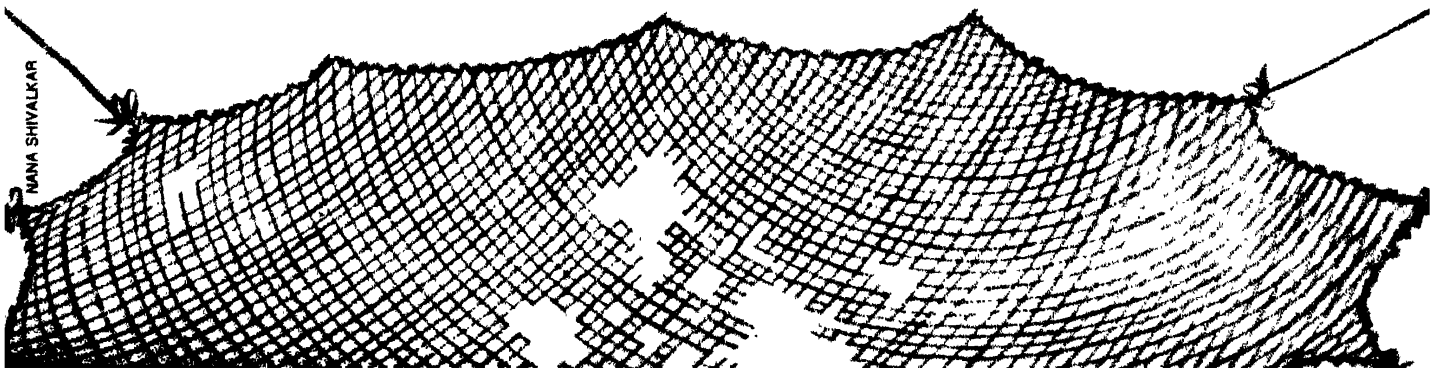
In addition to better satellite reception capability, plans have been drawn up to locate a large number of Data Collection Platforms (DCP) along inaccessible and remote areas over land and sea. These platforms will transmit data on wind, pressure and temperature to the INSAT which, in turn, will communicate the data to the Meteorological Data Utilisation Centre in New Delhi. The data will be used to predict weather; the cyclone warnings could then be transmitted via the same satellite to clusters of villages located in those vulnerable sectors on the Indian coastline. These innovations should have a positive impact on the early warning system in the coming decade.

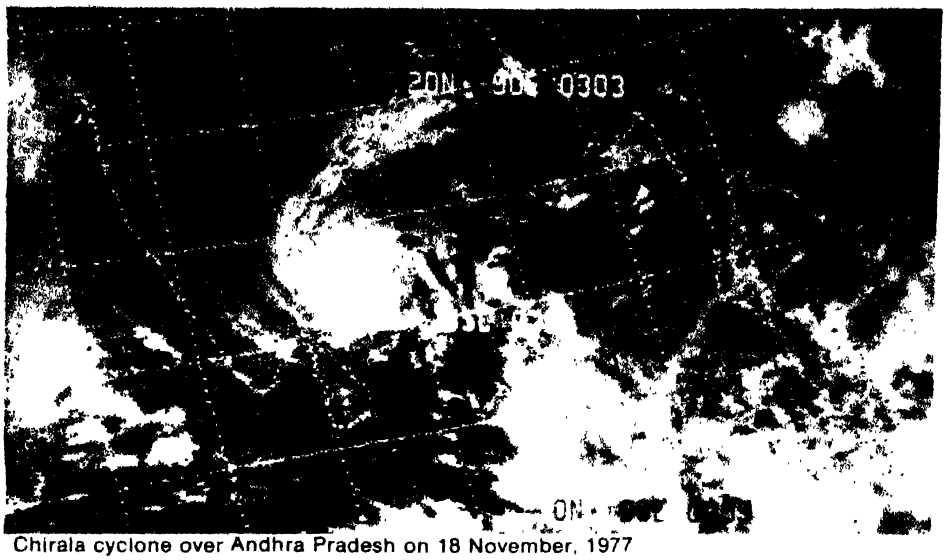
One of the limitations of the warning system is its inability to predict the landfall of a cyclone (the point at which the cyclone hits the coast) accurately; the cyclone might strike 150 km on either side of the predicted landfall. Thus, evacuation measures have to be initiated over a sector of 300 to 400 km width along the coastline. And generally, evacuation needs to be completed within 24 hours. This is costly in terms of manpower and resources. Greater precision in prediction can circumvent this difficulty.

Another useful monitoring device is a coastal radar. There is a network of seven coastal radar stations in India today. Five of them are located on the east coast and two on the west. An eighth coastal radar will be installed at Machilipatnam, Andhra Pradesh, in a year's time. Despite this radar surveillance system, it is difficult to anticipate recurvature of cyclones because they occur with great rapidity. The mechanics of recurvature is now the subject of considerable research. This is closely linked with certain features of the cyclone, such as its "eye" and the radius of maximum winds. In simple terms, the formation of the eye may be visualised in terms of the total energy and the angular momentum of spiralling winds around a centre of low pressure.

If r is the radial distance from the centre of the cyclone, and v is the tangential velocity of the wind, then its angular momentum, relative to the rotating earth, is rv. But as we see, the wind conserves its angular momentum, so that v should increase indefinitely as r begins to decrease. This is not possible because the total energy of the cyclone remains approximately invariant. Unable to exceed a critical value, the winds then begin to rise upwards and spread outwards in the upper atmosphere over a cyclone. The value of the radial distance (r) beyond which no further increase in wind speed is permitted determines the radius of the eye. The radius of the eye is closely linked with storm surges which represent the elevation of the sea level, as the cyclone hits the coast. Storm surges lead to coastal inundation which causes the greatest damage. The elevation of the sea level is brought about by changes in the atmospheric pressure, and the resultant winds which drive the surface sea water towards the coast. The cyclone which hit Bangladesh on 12-13 November 1970 was believed to have generated a surge between four and seven metres.

It is now possible to develop mathematical models which indicate how much the sea level is likely to rise when an idealised cyclone, with specified central pressure, maximum winds and eye hits a given area of the coastline. Apart from the storm characteristics, the model output is sensitive to contours of the sea bed. Although modelling experiments are in an early stage of development, the outlook is encouraging. The results of model predictions and actual observations of the total sea level elevation have shown a fair degree of agreement in some cases. The problem





Chirala cyclone over Andhra Pradesh on 18 November, 1977

areas in this field are: (i) interactions between the cyclone-induced surge and the astronomical tide (normal tides caused by the sun and the moon), (ii) the retarding force due to sea-bed friction, and (iii) the coupling between an ocean surge and the river discharge near estuaries.

Meaningful solutions to these problems are likely to emerge in the near future because the required computer capability, in terms of speed and size of memory, is now becoming available in India.

Floods and droughts

Most river floods are caused by heavy rain or, in mountainous regions, by large snow melt. Such floods are often accompanied by the sudden failure of dams and landslides which add to the distress of the community.

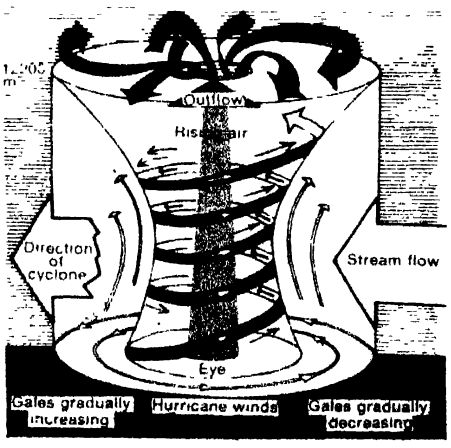
Heavy rainfall is often caused by tropical cyclones, especially in their forward sectors. In India, floods are also caused by the passage of depressions during the monsoon. A depression represents a vortex in which winds rotate round a centre of low pressure, but with less speed and intensity than in a cyclone. The direction of rotation is counter-clockwise in the northern hemisphere. During the monsoon, a number of depressions form over the northern sectors of the Bay of Bengal. They generally move westwards to the central parts of the country. Some begin to recurve northwards towards north-west India after moving initially towards the west.

The exact mechanism which leads to the formation of these depressions is not yet clear; some of them are generated over the northern parts of the Bay of Bengal, while some can be traced as migratory low pressure systems which move westward from the South China Sea. What makes the northern parts of the Bay of Bengal so favourable for the formation of monsoon depressions? It has been suggested that when the horizontal and vertical gradients of winds decrease, conditions become favourable for the formation of circular vortices. But this type of reasoning ignores the thermal pattern of the atmosphere. When temperature gradients exceed certain limiting values, both along the horizontal and the vertical direction, the air becomes unstable. There is an intimate relationship between the gradients of temperature and wind, and one cannot consider only one of them.

In very large rivers such as the Ganga and the Brahmaputra, the flow is relatively slow to change in downstream regions. On the other hand, small catchments are often devastated by "flash-floods". Flash-floods provide very little time between the start of the flood and the peak discharge. Floods of this type are particularly dangerous, because there is little time to evacuate the population.

Just like cyclones, depressions also often change their tracks and recurve in an unexpected manner. When this happens, it is difficult to provide adequate warning against floods. There were two instances in recent years when this happened. The first one occurred between 12 and 20 September, 1976. A cyclonic storm crossed the coastline a little to the south-west of Calcutta and weakened into a depression by about the 13th after moving west-north-west. But it suddenly recurved, when it was located south-west of Varanasi on 13 September, and moved eastward to Hazaribagh after traversing large areas of Uttar Pradesh and Bihar between the 13th and the 16th Having reached Hazaribagh on the 16th, it changed its track and began to move north-eastward towards Bhagalpur. There were extensive floods because the Ganga and its tributary, the Punpun, inundated their banks. The Punpun registered a sharp rise of 3.5 metres in 24 hours. The highest rainfall in a 24-hour period, as recorded at Hathidah situated on the south bank of the Ganga, opposite the industrial town at Barauni, was 44 cm on 20 September.

Structure of a tropical cyclone



How depressions and cyclones exhibit recurvature and change tracks is not understood. The situation might improve in the coming decade with better monitoring facilities. If the tracks of the cyclone or depression are monitored, for example, every half an hour, it might become possible to identify the first indications of a possible recurvature.

Short period variations in monsoon rainfall are closely associated with periodic movements of an elongated low pressure area, known as the monsoon trough. Its line of symmetry, or its axis, as it is popularly known, is oriented in an east-west direction roughly parallel to the southern periphery of the Himalayas. Recent investigations suggest that the formation of the trough is not merely a mechanical effect due to the mountains in the north and the east; it appears to be linked with imbalances in the earth-atmosphere radiation system. Observations with weather satellites suggest that the difference between (i) incoming solar radiation, and (ii) the outgoing radiation emitted by the earth and the clouds is only of the order of 50 watts metre^{-2}. There are certain parts of north-west India and the Indo-Gangetic plains where the difference is large in some years and small in others. Research is now in progress to find out whether such imbalances generate the monsoon trough.

We do not yet know what makes the axis of the monsoon trough move northwards to a position very near the Himalayan foothills at certain periods of the monsoon, and southwards to the Indo-Gangetic plains at other times. However, it is observed that when it moves north to the

foothills, the rainfall is confined almost entirely to north-east India. This leads to floods in the Brahmaputra and the Kosi. On the other hand, when the axis moves south, the monsoon rain belt is confined to the Indo-Gangetic plains, and north-east India remains dry. One view is that a highly non-linear system, such as the atmosphere, may have several states of equilibrium. There is the possibility of a rapid change from one equilibrium state to another. It would be interesting to investigate whether this type of change could account for alterations in the location of the monsoon trough.

Three aspects are basic for monsoon prediction: (i) the dates of onset and withdrawal of monsoon rains, (ii) the total quantum of rainfall from 1 June to 15 September, and (iii) periods of lean or heavy rainfall within the monsoon season. The first two problems are related to the general question of inter-annual variability of monsoon rains. Specifically, what we need to know is, why does the monsoon perform well in some years, but poorly in others?

Of late, a number of attempts have emerged, which seek to associate the monsoon's performance with extra-tropical features such as the development of pronounced high pressure areas over Europe or an increase in the number of low pressure systems over north India. There appears to be a danger of adopting a 'hit-or-miss' type of approach towards this prediction problem. Unless adequate consideration is given to the physics of the atmosphere, any success that may be claimed is more likely to be of an accidental nature.

Viewed as an exercise in projecting a statistical time series, of rainfall, for example, the new methods may hold some hope for the future. One such technique is an Auto Regressive Integrated Moving Average (ARIMA) approach. This seeks to resolve a time series into a part which is generated entirely by past history (auto-regressive), and a part determined by a series of random shocks. The principal difficulty with the time series of a meteorological variable such as rainfall is that the series is not stationary; its statistical properties keep changing with time. Modelling experiments will help to improve our understanding of the physics of such changes.

Modelling experiments

The progress in modelling atmospheric systems has been encouraging in the last few years. A number of experiments which try to simulate different facets of the Indian monsoon have been conducted with the help of mathematical models. In a recent paper, W. L. Gates, an eminent meteorologist, states: "If man's increasing alteration of the environment results in the introduction of previously unknown influences on the climate, the modelling approach is the only method which can be used to predict the future course of climate". This is especially relevant to the forthcoming ambitious project, "World Climate Programme", in which the World Meteorological Organisation and the International Council of Scientific Unions are going to participate. The project is designed to improve the monitoring and the modelling aspects of weather systems. The objective here is to try and understand what is the mechanism of inter-annual variability of largescale systems, such as the Indian summer monsoon.

The governing mathematical equations in such models are based on the physical laws of fluid motion, which were enunciated by Navier and Stokes nearly 100 years ago. The complexity of these equations were solved with the advent of electronic computers.

The Navier-Stokes equations are based on Newton's Second Law, which asserts that changes in the motion of a fluid are brought about by the action of body forces which, in turn, are expressed by the rate of change of momentum of the fluid. For action in the atmosphere, which is also a fluid, the main body forces are those generated by a gradient of pressure and the retarding effect of friction near the earth's surface. In addition, there are sources and sinks of heat created by imbalances in the earth-atmosphere radiation budget. There are also complications created by the thermal structure of the atmosphere. Unlike the motion of water in a pipe, the motion of air is guided to some extent by the vertical temperature profile of the atmosphere.

Computer-oriented prediction techniques have the great advantage of speed over older manual methods. The older methods called on simplified techniques of extrapolation. For example, if a pressure system, such as a depression, was located on a given weather chart at a certain time, the meteorologist had no option but to assume that it would continue to move with the same speed and intensity in the next 24 or 48 hours. This assumption was hardly ever justified, because pressure systems never moved with regularity to oblige the forecaster.

An attempt was made, around the time of the First World War, by L. S. Richardson, a British mathematician, to use the equations of Navier and Stokes to predict the weather. Richardson felt it would require an amphitheatre with 64,000 scientists working with desk calculators to be able to compute the next day's weather. Forty years ago, a group of scientists assembled at Princeton, USA, under the mathematician Prof. J. Von Neumann to try out a programme on one of the earliest electronic computers of the day for weather prediction. Surprisingly, the computer was able to generate outputs, which looked sufficiently close to reality to make further attempts seem worthwhile. Since then, much research has gone into experiments designed to simulate the behaviour of the atmosphere. In India, sufficient computer capability is now being built up to take up this new and challenging task. The India Meteorological Department has been experimenting with numerical models for the last five years, and some of the model outputs are beginning to be used for routine weather prediction.

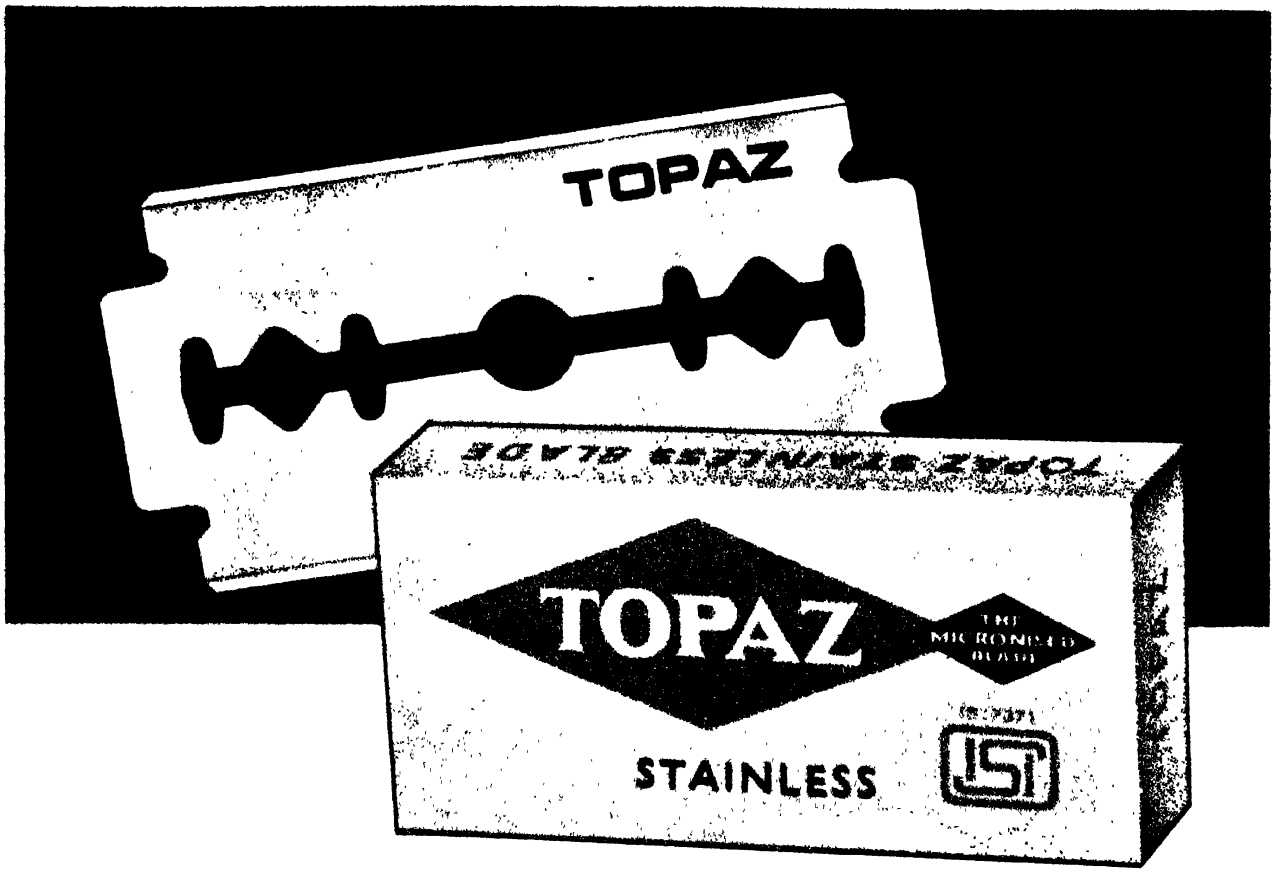
This is specially relevant to future developments in India's space programme. The satellite, *Bhaskara,* was equipped with a radiometer for measuring the temperature equivalent, known as the brightness temperature, over different parts of India. The central problem here is to try and discover a relationship between the brightness temperature and the actual conditions prevailing over the earth's surface. This would be achieved by developing models to estimate, for example, the impact of conditions over the sea or the distribution of clouds and the aerosols in the atmosphere on the brightness temperature measured by the satellite.

Clearly both monitoring and modelling aspects must supplement each other because it would be futile to merely collect information without being able to use them, just as it would be meaningless to develop models with insufficient realism. An integrated approach is the *sine qua non* for progress in the coming decade. There are encouraging signs to suggest that this is increasingly realised by scientists in India.



Dr Das is currently Director General of Meteorology, India Meteorological Department, New Delhi. Dr. Das was formerly a member of the Joint Organisation Committee (JOC) for the scientific management of Global Atmospheric Research Programme (GARP) launched, jointly, by the WMO and the international Council of Scientific Unions (ICSU). In 1979, he was elected a member of the Executive Committee of the WMO He has written a technical note on Storm Surges published by the WMO and also a book titled *The Monsoons.*

India's No.1 today...
World's No.One tomorrow...



TOPAZ—the fastest growing blade in the World

Available in :

Abu Dhabi • Aden • Afghanistan • Bahrain • Bangla Desh • Djibouti • Dubai • Egypt • Ethiopia • Fiji • Great Britain • **India** • Iran • Jordan • Kuwait • Lebanon • Libya • Malawi • Malaysia • Morocco • Nepal • New Zealand • Nigeria • Pakistan • Saudi Arabia • Sierra Leone • Singapore • Somalia • Spain • Sudan • Syria • Taiwan • Thailand • Yemen • Yugoslavia • Zaire.

No wonder More & More people choose

TOPAZ

The all time Leader

A MALHOTRA QUALITY PRODUCT

2480

Food for home science

A Textbook of Applied Chemistry by T Jacob, Macmillan, 1979, 415 pp Rs 25

THE UNIVERSITY Grants Commission has a scheme under which a university or college teacher can get special leave (when they need not do their normal duties in their colleges) and write a textbook, or do something of that sort After the completion of writing, the teacher resumes duties and has to find a publisher as the UGC does not take the responsibility of publishing it The book under review is one such attempt

The author, who is head of the chemistry department at Lady Irwin College, New Delhi, had elected to write on applied chemistry comprising drugs and medicines, cosmetics and perfumes, textiles and plastics and the like as a textbook for students of home science and allied sciences Judging from the acknowledgements, it seems that the author got the help mainly of biochemists, nutrition experts, entomologists and dermatologists (perhaps that is why the chapters on drugs pesticides and chemical poisons in food are much better than the rest) However a major portion of the book deals with other fields of technology involving metals, textiles plastics oils, etc

The chapter on drugs and medicines deals effectively with various types of drugs including antibiotics anaesthetics analgesics, and antihistamines They follow a more or less uniform pattern comprising brief histories properties medicinal value, after-effects and precautions The extraction from natural products, synthetic routes and properties of essential oils, perfumes and flavourings are dealt with in the next chapter A large number of cosmetic preparations ranging from tooth pastes and toilet soaps to face creams and hair removers, along with their chemical composition, and hints for selection of a suitable product with detailed recipes in some cases are covered in the fourth chapter Domestic fuels and their hazards, fire prevention and protection, common metals and alloys and corrosion and care of metals form the subject of the next four chapters Plastics and allied products followed by textile chemistry and pesticides are then described The final chapters discuss chemical poisons in foods and environmental pollution

Extensive use of tables has been made in presenting information of comparative nature, which includes much on important essential oils of India, important perfumeries, cosmetics, properties of fuels, alloys and textile fibres Environmental pollution, hazards involved in the use (or misuse) of metals, cosmetics, fuels, pesticides, medicines and drugs have also been sufficiently highlighted

On the other hand, the chapters on textile chemistry deal almost entirely with the chemistry, preparation, properties, identification, etc of textile fibres But textile chemistry deals mainly with subjects like bleaching, dyeing printing and mercerising Home science students are definitely expected to know about these topics, but both these chapters do not throw any light on these aspects of home science, except for a short paragraph on chemical finishing of textiles and a table in which information is given without any explanation (pp 267 271) Most of the examples cited in the table on the classification dyes (pp 272 275) are the classical dyes and not the commercially important dyes of today Both the tables could have been dropped

The production and import figures of man-made fibres, petroleum, plastics, etc could have been updated to include more recent information Certain chemical structures are wrongly drawn Thus, the nitrogen atom of the pyridinium radical (p 29) has gone out of the nucleus, one of the nitrogen atoms of phenyl butazone (p 31) is shown with valency 4 (the double bond should be a single bond), the structures of meprobamate (p 32) and coumarin (p 56) are incorrect D-glucose is wrongly shown (p 202) as the monomer of both cellulose and starch In the chemical poisons in foods, the harmful metanil yellow, often used to colour sweetmeats, should have been included Safe food colours like erythrosin, amaranth, tartrazine, etc should also have been included

On the whole, the book is a good attempt in educating an individual, who is not a specialist in medicine, metallurgy, plastics and fibre technology, in these and allied aspects of applied chemistry

V A SHENAI

Dr Shenai is Reader in Fibre Science in the Department of Chemical Technology University of Bombay

RIA in practice

Radioimmunoassay and Related Techniques. Methodology and Clinical Application by Jan I Thorell and Stevan M Larson The C V Mosby Company USA 1978 x+298 pp US $-23.5

RADIOIMMUNOASSAY (RIA) today a potent analytical tool in bioscience has brought about very important advances in endocrinology It has been shown by experience that virtually any immunogenic substance (or one that can be rendered immunogenic) may be determined by this versatile technique The major advantage of this procedure is the ability to measure minute quantities that are difficult to measure by other means Immunoradiometric assay, radio receptor assay, and enzyme immunoassay are the related techniques

Thorell and Larson have made a good effort to introduce the subject and various concepts of RIA in easily comprehensible language The book becomes a valuable aid to students and practising scientists in biochemistry, molecular biology, microbiology and medicine who use RIA as an investigating tool

Comprising two parts methodology and application, as the title indicates Part I deals with the practical and theoretical aspects of RIA Receptor, radioligand, separation procedure, assay performance data processing and quality control are discussed in this part Care has been taken to include even minute details Also, the possibility of errors in assay is elaborately dealt with In this regard, the book relates the authors' experiences

The chapter 'Data Processing and Quality Control', which introduces the theory of assay optimisation, provides only the sketchiest outline of the mathematical foundation of assay optimisation Here, the authors fail to include the exact derivation of equations

In spite of its title the book does not provide any account of enzyme immunoassay, which may replace RIA in some cases where high sensitivity is not required A list of definitions of terminology where antigen is defined as a substance which causes the production of antibodies and reacts with antibodies" appears vague The term immunogen" seems more appropriate for this definition

The second part, dealing with the clinical application, is well written with diagrams to explain the RIA procedure applied to different hormones All the chapters, especially those on placenta and fetus, thyroidaxis and pituitary hormones give the latest information and end with essential and relevant biography and well selected references

At the end of the book the appendices give details of how to carry out the RIA procedure practically It includes preparation of hormone-free serum antibody testing, assay procedure, preparation of immunogens, radio labelling of hormones, preparation of steroid derivatives, calibration of counters, etc, Preparation of immunogen and derivatives for iodination of progesterone cortisol and testosterone are discussed The book can serve the purpose of self-study to a great extent

N SIVAPRASAD

Mr Sivaprasad is with the Isotope Group, Bhabha Atomic Research Centre, Bombay

For clean, soft AFTER-SHAVE SKIN...





Whether your skin is normal, or dry, or oily, Erasmic now has a Shaving Cream to suit your type of skin... specially formulated to leave your skin clean and soft after your shave. Experience Erasmic today.

- Antiseptic — for normal skin
- Cream Rich — for dry skin
- Lime fresh — for oily skin

Erasmic introduces a cream to suit every type of skin

Quality Products by HINDUSTAN LEVER

LINTAS-ERS.CR-25-1915

If...



... there were no cosmic rays

A FEW years ago, Prof Van de Hulst, a Dutch astrophysicist remarked "Actually, the word cosmic rays, at the time the name was given, was a curious double confession of ignorance—cosmic meaning that we did not know from where they were coming and ray meaning that we did not know what they were!" So, one may ask what is lost, other than cosmic ray scientists' jobs, if cosmic rays were not there? Let us see

What are cosmic rays? Along with lunar samples and meteorites, cosmic rays are unique samples of extra-terrestrial matter While the former two belong to the solar system, cosmic rays mostly come from outside the solar system They consist of energetic charged particles, over 90 per cent being protons the rest are nuclei, in varying abundances from helium to possibly even uranium Their energies range from 10^8 eV to as high as 10^{20} eV which is 100 million times the highest energy reached by man made accelerators The energetic galactic cosmic rays above 100 MeV come from outside the solar system from the galaxy as a whole or even possibly from outside the galaxy But our sun too is a source of mainly low energy cosmic rays it accelerates particles up to a few tens of MeV in solar flares

If there were no cosmic rays, some of the elements will be much rarer All elements have been cooked either in the interior of normal stars or in the explosive process of supernova, using primordial hydrogen and helium as starting materials There are some elements like lithium (Li), berillium (Be) and boron (B) which, though produced in stellar interiors, are burnt up quickly in nuclear reactions and transmutate into other elements The abundance of these elements, though ten thousand times less than that of carbon, is still much larger than what one will expect from nucleosynthesis Cosmic ray protons and helium nuclei, while passing through the interstellar matter, collide with the atoms of carbon, nitrogen, oxygen etc present, and disintegrate them, producing the light nuclei Li, Be and B

Cosmic rays have probably played an important role in the evolution of life on the earth Cosmic rays entering the earth's atmosphere multiply, producing a significant dose of radiation at the earth's surface Radiation is an important cause of mutation in living organisms Cosmic rays should then have played an important role for the evolution of some life forms They could also have been responsible for the sudden destruction of some life species

There have been periods in the earth's history when the magnetosphere was weak as during reversals of magnetic fields A weak magnetosphere allows an increase in the flux of cosmic rays reaching the earth The consequent increase in radiation probably resulted in drastic changes (SCIENCE TODAY, February 1980, p 63 and March 1980, p 56)

Of course, the absence of cosmic rays will make exploration of space by man easier, since astronauts would not have to worry about radiation damage If the earth were to be shielded from cosmic rays, we will not have disturbance in radio communication which occur during solar magnetic storms and flares And gone will be the aurorae seen now at the poles

Though the flux of cosmic rays is small, they have a significant role to play in the dynamics of the galaxy itself Our galaxy is disc-shaped with a diameter of 90,000 light years and a thickness of only about 600 light years Most of the matter consists of stars with about 10 to 20 per cent in the form of gas mostly hydrogen It is this gas which provides the material for the formation of stars The thickness of the gas disc results from a balance of gravitational attractive force and the force exerted by the gas pressure In addition to the gas pressure we have the pressure exerted by the largescale magnetic field and the cosmic rays It turns out that the energy density in cosmic rays which is of the order of 1 eV per cubic centimetre is comparable to the energy density of the magnetic field as well as the kinetic energy density of the gas itself Thus, cosmic rays play a vital role in maintaining the observed thickness of the galaxy

A notable feature of the interstellar gas is that it is not uniformly spread, but is lumpy, the self-gravitation of the interstellar gas can lead to the so-called Jean's instability, resulting in the lumpiness But this self-gravitation is not strong enough to maintain the observed clouds It turns out that if one considers the effect of cosmic rays and the magnetic field, the instabilities are about five times stronger than that due to gravitation The clouds thus formed are believed to be the sites where new stars are formed The heat input to the interiors of these clouds is, once again, provided by cosmic rays which can penetrate these clouds and ionise the matter therein On the other hand, photons from stars cannot penetrate deep into the clouds The ionisation produced by cosmic rays is also helpful in making complex molecules Though the process of molecular formation is not known in detail, it is well known that the reactions proceed more speedily if ionised atoms are present

Nature abounds in beautiful examples of closed cycles It is exciting to see such a manifestation in such a basic process as star formation While cosmic rays help in the process of star formation, they themselves are the creation of stars, and most are probably made during their dying moments, that is, during supernova

T N RENGARAJAN

Dr Rengarajan is with the Infrared Astronomy Group, Tata Institute of Fundamental Research, Bombay

Cosmic rays in other sciences

Cosmic rays are useful in mapping the universe. A very important source of radio emission is the synchrotron radiation emitted by energetic electrons spiralling in magnetic fields. Radio emission from cosmic ray electrons in the interstellar space is an important tool to study this medium. The spectacular radio galaxies going strong for millions of years pouring out radiation at the rate of 10^{47} to 10^{48} ergs per second again owe their origin to the energetic electrons, though we do not know how the energy storehouse is maintained. Cosmic rays are the basis of gamma-ray astronomy, too. Gamma-rays, which are energetic photons, are produced in collisions of cosmic-ray nuclei with interstellar atoms or in the interactions of cosmic electrons. Many of the fundamental particles like pions, muons, kaons and positrons were first discovered in cosmic rays. Cosmic rays interacting in the earth's atmosphere constituted the first [illegible] in which particle [illegible]

studied. Later, it led to the construction of accelerators where such studies could be done with better precision. Even now, for studying reactions above 10^{12} eV, we have to enlist cosmic rays. It is unlikely that man can ever accelerate particles to the highest energies that the cosmic rays do.

Cosmic rays have greatly aided our understanding of our own civilisation and history. The technique of carbon-14 dating of archaeological samples owes its existence to cosmic rays. The secondary neutrons produced by cosmic rays in the earth's atmosphere interact with nitrogen nuclei to form the radioactive ^{14}C atoms which have a half-life of 5,570 years. These radioactive isotopes get incorporated into vegetation through the 'carbon life cycle'. Once the plant dies, the accumulation of ^{14}C stops. Hence, the amount of ^{14}C present now tells us the time elapsed since then. Cosmic rays also produce in the atmosphere other useful isotopes, both stable and unstable, which act as tracers for investigating geophysical and geochemical [illegible]





The seventh and last 'W' of the series in the medico-legal aspect of crime detection answers the most important question—whether the case is a homicide, suicide or accident



The Doctor as Detective

Murder?
Suicide?
Accident?

Pritham P. Phatnani

This body found in a well looked like a murder case at first, the inference being that the man was done to death and dumped in the well after his hands and feet were tied together. Closer inspection showed that only the left hand (right) was tied, while the right was free (see text)

A MAN was found drowned in a well with his hands and feet apparently tied together. The police officer taking charge of the body concluded that it was a case of murder. But a careful examination of the body by forensic pathologists revealed that the ankles were tied together by the dead man's own lungi in a figure-of-eight knot which could be easily slid half way up to the knees. His left hand was tied with his bush-shirt in a single knot, while the right hand was holding the free end of the garment. Obviously the deceased had tried to tie his hands and feet together with his own clothing but had been unable to tie himself up completely, before jumping into the well, so as to prevent his struggling in the water and to enable him to go down easily to the bottom.

In a case of unnatural death, the first question to be answered by the police is whether it is a case of suicide, murder or accident. This saves considerable time and energy and avoids casting unnecessary suspicion on innocent persons. Very often a murderer, after committing the crime, makes it out as a case of suicide, or even an accident to mislead the police. A person committing suicide wishes to avoid the stigma of suicide and tries to make it look like murder. At times, accidents look like homicides. Hence, the crime investigator has to study the scene of incident and the body very carefully to interpret the physical evidence correctly.

Often it so happens that the relatives of the victim innocently destroy the evidence because they want the house to look neat and clean when the investigating team arrives at the scene of the crime. As against this, sometimes the relatives themselves destroy the evidence wilfully in suicide cases to prevent the stigma of suicide from being attached to the family name. Let us now see how a case can be determined as homicide, suicide or accident.

Typical injury in a case of suicide by firearm



Suicides often leave behind written notes about their intentions and actions and may mention the reasons for taking their lives. At times no such note is left behind and one has to come to conclusions from other evidence around the body and the scene of crime.

Persons committing suicide adopt means which are easily accessible to them. Self-immolation by sprinkling kerosene on the clothes and setting them on fire is one of the commonest methods adopted by women, specially the young, newly married ones. This is followed by consumption of poison, most commonly an insecticide. Drowning is another means by which they end their lives. Other violent means like hanging or injuries with weapons are more common with men than in women. However, there is no hard-and-fast rule. Men, too, burn themselves and consume poison and women also are found to hang themselves. Jumping from tall buildings and throwing oneself on the railway track are other means of committing suicide.



The suicide can generally be distinguished by the location of the injuries. The suicides generally inflict injuries on the most accessible parts of the body like the neck, front of chest, abdomen, wrist, etc. When they use firearms, they choose the temples, the mouth or the front of the heart or the pit of the stomach. If more than one injury has been attempted with knife, specially on the neck and wrist, they are called hesitation cuts.

People committing suicide usually employ common household poisons like various insecticides made of organochloro or organophosphorus compounds, opium, copper sulphate, corrosive acids, etc.

Hanging is almost always suicidal, whereas strangulation is almost always homicidal.

The psychology of the suicide is typical, and is important in the investigation. Any untoward event in life, such as being crossed in love, failure in examination, financial loss and any family quarrel, may give indications about the death being suicidal. He may appear depressed and behave abnormally prior to death. However, at times the person may not give any such hints of his suicidal intent.

The means adopted by the suicide are also tell-tale (see SCIENCE TODAY, May 1980, p. 68). These straightforward cases do not pose

problems for the investigator. But, when high dignitaries, political leaders, famous personalities or even commoners die suddenly in unusual circumstances, doubts are raised A shipping magnate jumped to his death from his 11th floor office. There was great speculation about foul play until a very careful study of his office premises revealed evidence about the great disturbance that had been going on in his mind immediately prior to his death The physical evidence relating to the method adopted for jumping out of the office windows situated at shoulder height, and the patterns of injuries on the body subsequently left no doubt that it was a case of suicide

When there are eye-witnesses to an accident, there is little doubt as to the cause of death But when they occur without any eye-witness, foul play cannot be fully ruled out

Mostly, doubts arise in hit-and-run cases and when people fall from heights, where the relatives may think that the deceased must have been pushed down More often than not, accidents involve children and occur while they are playing about Adults are involved when at work or during sports, although domestic accidents like electrocution do occur at home Transport or vehicular accidents involve children and adults alike Women are quite often burnt accidentally while cooking Accidents also occur during festivals, specially during Mohurrum, when there is a ritual among the mourners of whipping themselves with knife blades tied to a chain Often these blades go awry and penetrate the person's body with fatal results

Homicides are the real challenge

But it is homicides that are the real challenge to the crime investigator In the so-called ' open and shut cases ' there is little more to be done than connecting the material evidence with the accused But there are no cut-and-dried solutions for the investigator when a homicide is made to appear as a suicide or an accident, or when the body has been mutilated or dismembered beyond recognition The investigation becomes difficult and the answers to the six Ws have to be worked out as described in earlier articles (SCIENCE TODAY January to June 1980)

Often the very nature of the injuries is such that they could not have been caused by the deceased himself, such as multiple stab wounds all over the body including on the back, hence, suicide is ruled out The absence of a weapon in the vicinity of the body would also strongly suggest that the deceased has been done to death The evidence of a struggle at the scene of the crime, or unnaturally placed articles of common use or even their absence from their normal settings, would suggest homicide

In the now famous Colaba call-girl case (see SCIENCE TODAY June 1980, p 68) where a call-girl was thrown down from the balcony of the house, the killer had tried to make it out as an accident, trying to destroy the evidence of her presence in the room by throwing away her personal belongings which were found scattered around the body of the woman on the ground The physical and other evidence suggested a struggle in the room and established murder

In another case a woman was found shot dead in a hotel room and the case was made to appear as a suicide But from the direction of the bullet injury, the deflection of the bullet from the wall, the position of the bullet and absence of a weapon at the site and other physical evidence clearly suggested that the case was a homicide and not a suicide

Through the series of articles we have seen how a medical doctor can help in solving crime It is not only the guilt of a person that is established, but quite often it is possible to prove the innocence of a suspect also Let me quote a couple of cases In one case of sexual murder, a five-year-old girl was strangulated after sexual assault A known exhibitionist in the locality was brought in as a suspect Physical examination of the suspect established that he had, in fact, not indulged in sexual intercourse for several days And after intensive investigations the real culprit was arrested

In another case an unmarried mother, who was a maid-servant, was tried for infanticide, it was possible to establish that the injuries on the infant could also have been caused during the process of birth She was given the benefit of the doubt and acquitted

Self-inflicted injuries with knives used for whipping in a religious ritual were responsible for death





Even an innocuous thing like a balloon can cause death This child swallowed a balloon while blowing it The balloon blocked the windpipe and cause asphyxiation Here the windpipe has been dissected out to show the balloon

Culpable homicide

Lastly, the case was decided in the Bombay Sessions Court a couple of months ago where a young man had killed his mother in self-defence when she had assaulted him with a knife in the course of a struggle He was convicted for a rash and negligent act not amounting to murder, because the medical evidence could establish that the injuries sustained by the mother were possible during a struggle and that the son himself had sustained injuries from the initial blows given by the mother Each of them had wielded a knife

Thus we come to the end of our survey of that facet of medical science which is not ordinarily known to the general public or known mainly through works of fiction, for when a crime is solved the credit generally goes to the long chain of police officers handling the case and when the case is decided in the court either way, it is the advocates who figure prominently The forensic scientist and forensic medicine men always remain the backroom boys, doing largely unglamorous work but often providing the crucial bit of evidence that clinches the case against the criminal

Dr Phatnani heads the medical education division of a well-known pharmaceuticals firm He is an Honorary Guest Lecturer in Forensic Medicine at the Seth G S Medical College, Bombay and a member of the Indian Academy of Forensic Sciences

Cross jump numbers

THERE are seven varieties of cross jump numbers. We shall discuss one of them.

Take any number of six digits. Divide it into a left part of four digits and a right part of two digits. Add one to each part. After this addition, transfer the right part to the left and the left part to the right. This gives the cross jump number with increment-1.

For example, take 732456. The left part is 7324 and the right part is 56. Add one to each part. The new numbers are 7325 and 57. Now cross them. 577325 is the cross jump number generated from 732456.

7324 56
57 7325 .... First jump.

Applying the same process to 577325, we get 265774. And the next cross number from 265774 is 752658, and from 752658 we derive 597527. Continue to generate new cross jump numbers.

However, one law should be remembered. When we add the two digits, the carry is to be neglected. Thus 7+5=2 and not 12. Thus 5738 +4 5732 and not 5742. Note well that the carry is not counted.

Continue the process further, and we get the original number at the 16th step (or at the 15th cross jump), a very attractive result!

732456	Starter
577325	
265774	
752658	
597527	
285976	5th Jump
772850	Note: (2859+1=2850)
517729	
205178	
792052	
537921	10th Jump
225370	
712254	
557123	
245572	
732456	15th Jump or 16th step.

This law of cross jump numbers generating the original number is true for any six-digit number. If the increment on both parts is raised to 2 instead of 1 then also we will get the original number at the 15th cross jump (or at the 16th step). Below, we take the same number 732456 with increment 2.

732456	.. Start
587326	.. First Jump
285875	
772850	If you take other
527720	increments instead
225279	of 1 or 2 say, 3, 4, 6,
712254	7, 8 or 9, the original
567124	number returns
265673	exactly at the 16th
752658	step or 15th cross
507528	jump.
205077	
792052	
547922	
245471	
732456	.15th Jump

But for increment 5, the original number comes at the 4th and not at the 16th step.

732456 ... Start
517329
245178
732456 ... Fourth step

This is the first variety of cross jump numbers. Other varieties will follow.

A row of nines in three steps

Take the number A (shown below). Reverse it to get B. Subtract B from A to get (A-B).

7 6 4 2 4 0 5 3 6 3 8 4 A
- 4 8 3 6 3 5 0 4 2 4 6 7 B

2 8 0 6 0 5 4 9 3 9 1 7 (A-B)

Now reverse (A-B); call it C. Add (A-B) and C.

2 8 0 6 0 5 4 9 3 9 1 7 (A-B)
+ 7 1 9 3 9 4 5 0 6 0 8 2 C

9 9 9 9 9 9 9 9 9 9 9 9 (A-B)+C

A funny mathematical result!

Here is a list of such numbers.

1) 7 2 4 5 1 0 6 3 5 3
2) 8 3 7 7 9 4 4 2
3) 8 5 5 5 2 0 6 4 7 7
4) 8 4 7 8 9 5 6 3
5) 8 3 2 4 5 2 5 0 4 0
6) 7 4 7 3 4 6 7 1
7) 9 6 3 8 5 4 9 1 7 3
8) 8 5 7 4 5 5 6 4
9) 4 5 5 5 5 4 6 3 8 2
10) 7 5 8 5 8 3 8 6
11) 8 5 5 4 6 2 7 1 6 0
12) 7 4 9 6 9 2 6 3

Many such numbers giving nines in three steps and even numbers giving nines in four or five steps can be prepared. Can the readers find the secret of preparing such numbers?

D.R. KAPREKAR

Science Today
August 1980
THE HIGHLIGHTS



Running into the wind

How aerodynamic designs are employed to improve the efficiency of ground vehicles. Roll up your car window shutters to save on fuel.

Understanding climatic changes

Increasing human activities may change the climate of the earth drastically. The global climate is difficult to monitor.

What stars and supernovae look like in X-rays

The Einstein X-ray observatory in space has opened new vistas in many areas of galactic and extra-galactic astronomy.

Immunology of malaria

It is possible to vaccinate against certain viral and bacterial diseases. Is an antimalaria vaccine on the way?

Medical education

Despite recommendations of various committees on medical education, teaching programmes in our medical colleges are antiquated.

How not to conduct an experiment

Some scientific experiments are not at all scientific.

If... the sun had a conscience also

IC-regulated DC supply

THIS is a fully solid-state, IC-regulated 6V DC supply for use with portable tape recorders, record players, radio receivers or any other equipment, working on battery cells, which you desire to operate on mains supply. The use of a single fixed voltage regulator IC provides regulated and ripple-free DC supply from a simple bridge-rectifier-filter supply. The ripple-free DC supply eliminates the hum level of an audio equipment. Only two components are used, in addition to the normal bridge-rectifier-filter circuit, the first being the voltage regulator IC itself and the second a 0.1 mfd capacitor across its output terminal to improve its transient response.

The simple circuit described below shows the regulated power supply for 6V DC output at 1 amp, most of the battery cell operated portable equipment being 6V DC. The step down transformer shown in the diagram provides 8V AC supply to the bridge rectifier using four BY 125s. The 1000 mfd capacitor provides filtration of the rectified output and provides about 10V DC to the input of the voltage regulator IC. The IC compares its output voltage with its internal reference so that the output provided is exactly 6V DC.

The chart below the electronic circuit diagram shows how to modify the circuit to suit different voltage outputs, for example, 5V, 12V, 15V and 24V. As these integrated circuits are of fixed voltage type, different output voltages will require different voltage regulator ICs. Fig. 2 shows the schematic equivalent and connection diagram of the fixed voltage regulator IC LM 340 XX and 78 XX series where the suffix XX denotes the fixed voltage output the IC will provide. These ICs are available for the following fixed output voltages: 5, 6, 8, 12, 15, 18 and 24V DC. All these ICs have three connections and are available in two different casings, plastic TO 220 and metal TO 3. The TO 3 type of casing is the same as the power transistor 2N3055 or MJ2499 you have already used.

The IC, in either of the two casings, is capable of supplying output current up to 1 amp. It has internal protections for thermal overload and short circuit current limit.

The voltage regulator IC must be mounted on a suitable heat sink or aluminium or copper sheet of area about 100 sq cm. Though the casings of these ICs are connected to ground, that is, zero volt (negative line as shown in the diagram), the IC can also be mounted directly on the metal chassis using it as a heat sink, but it is preferable to keep the heat sink isolated from the rest of the circuit as well as the unit's metal chassis.

You will need :

Semiconductors : Fixed voltage integrated circuit LM340 06 or 7806 - 1 No., Rectifier BY 125 - 4 Nos.

Capacitors : Electrolytic 1000 mfd/ 12V - 1 No. Polyester or ceramic 0.1 mfd - 1 No.

Transformer (made to order) : Pri : 230V AC. Sec : 8V at 1 amp - 1 No.

Approximate cost of the above components in Bombay market — Rs. 60.

Misc : 230V neon lamp, 1 amp fuse with holder, ON OFF switch, heatsink, red and

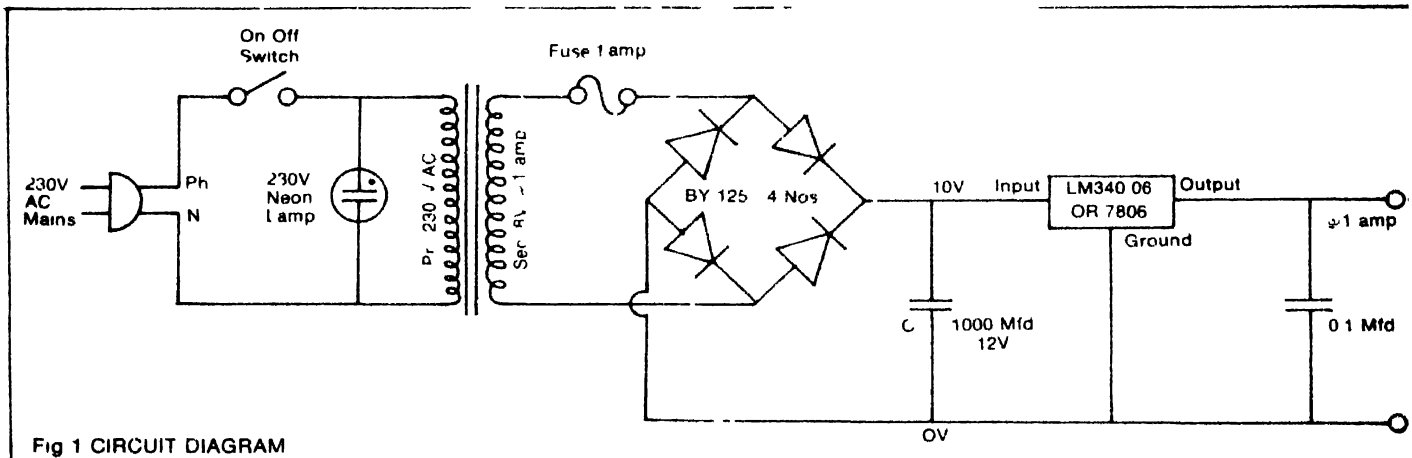
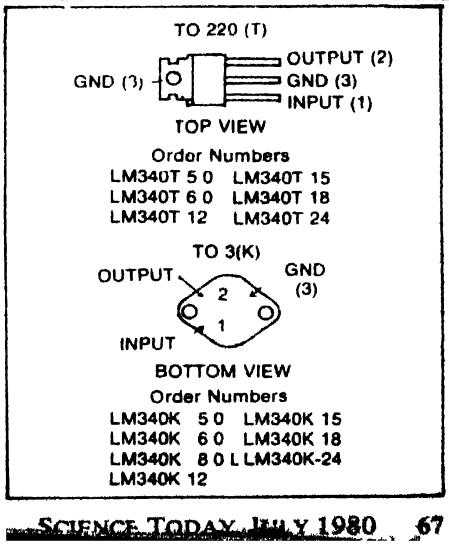


Fig 1 CIRCUIT DIAGRAM

DC regulated voltage required	Transformer secondary AC voltage at 1 amp	Filter capacitor 'C'	Fixed voltage regulator IC
5V DC	8V AC	1000 mfd - 12V	LM 340-05 or 7805
6V DC	8V AC	1000 mfd - 12V	LM 340-06 or 7806
12V DC	14V AC	1000 mfd - 25V	LM 340-12 or 7812
15V DC	17V AC	1000 mfd - 25V	LM 340-15 or 7815
24V DC	26V AC	1000 mfd - 50V	LM 340-24 or 7824

All other components are of the same value as shown in the above diagram for 6 V DC output

How to modify the circuit to suit different voltage outputs



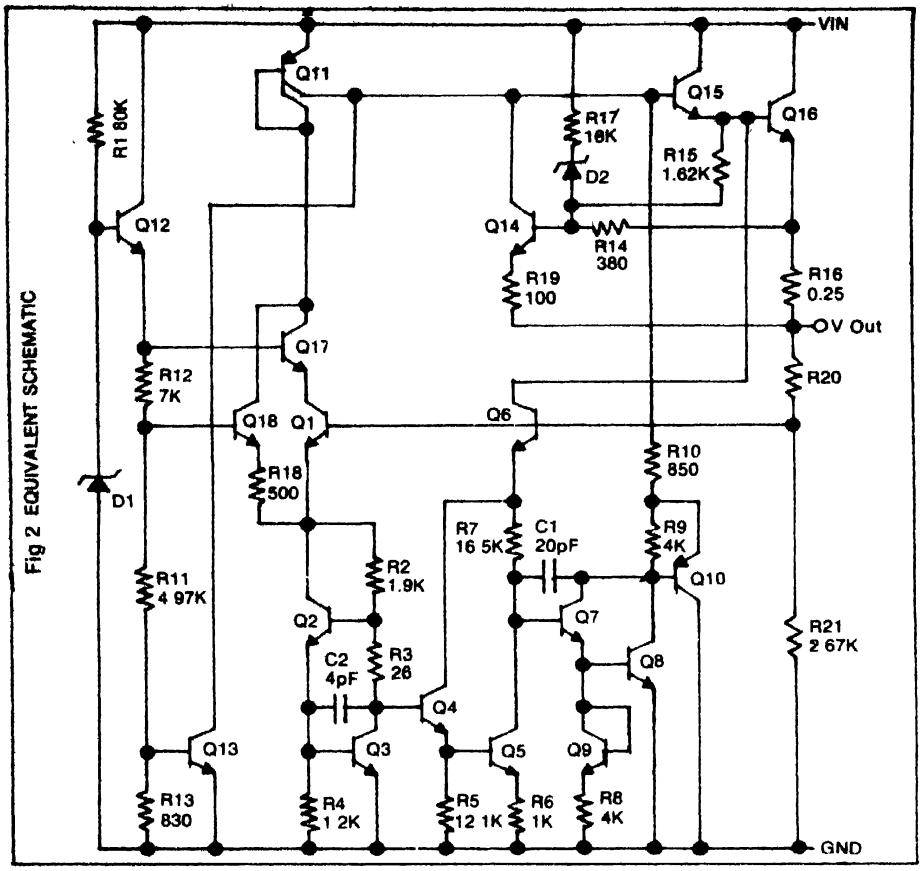


Fig 2 EQUIVALENT SCHEMATIC

black terminals, solder, wires, screws, suitable enclosure, etc.

ANIL V. BORKAR

Brain teasers

Roll numbers

My daughter returned from the school, after admission, with one of her classmates. I told them to add their roll numbers. My daughter gave the answer as 10 and after some time her friend said, "2475". I was surprised and asked them what they did. The former said she had subtracted, while the latter said she multiplied. What were their roll numbers?

V. A. SHENAI

(Solution next month)

Solution to last month's Brain Teaser

The clues give the following relationships:

$$T > J \quad ...(1)$$

$$D + A = J + T \quad ...(2)$$

$$D + J > A + T \quad ...(3)$$

(1) and (3) give $D > A$ ...(4)

Transposing in (3), $D - A > T - J$...(5)

Adding (2) and (5), $2D > 2T$

Hence $D > T$...(6)

(6), (1) and (4) make D maximum.

Subtracting (5) from (2), $2A < 2J$

$$A < J \quad ... (7)$$

(7) and (1) make A minimum. Hence, Dilip got the maximum and Ashok, minimum.

Awards and Appointments

Lady Tata Memorial Awards

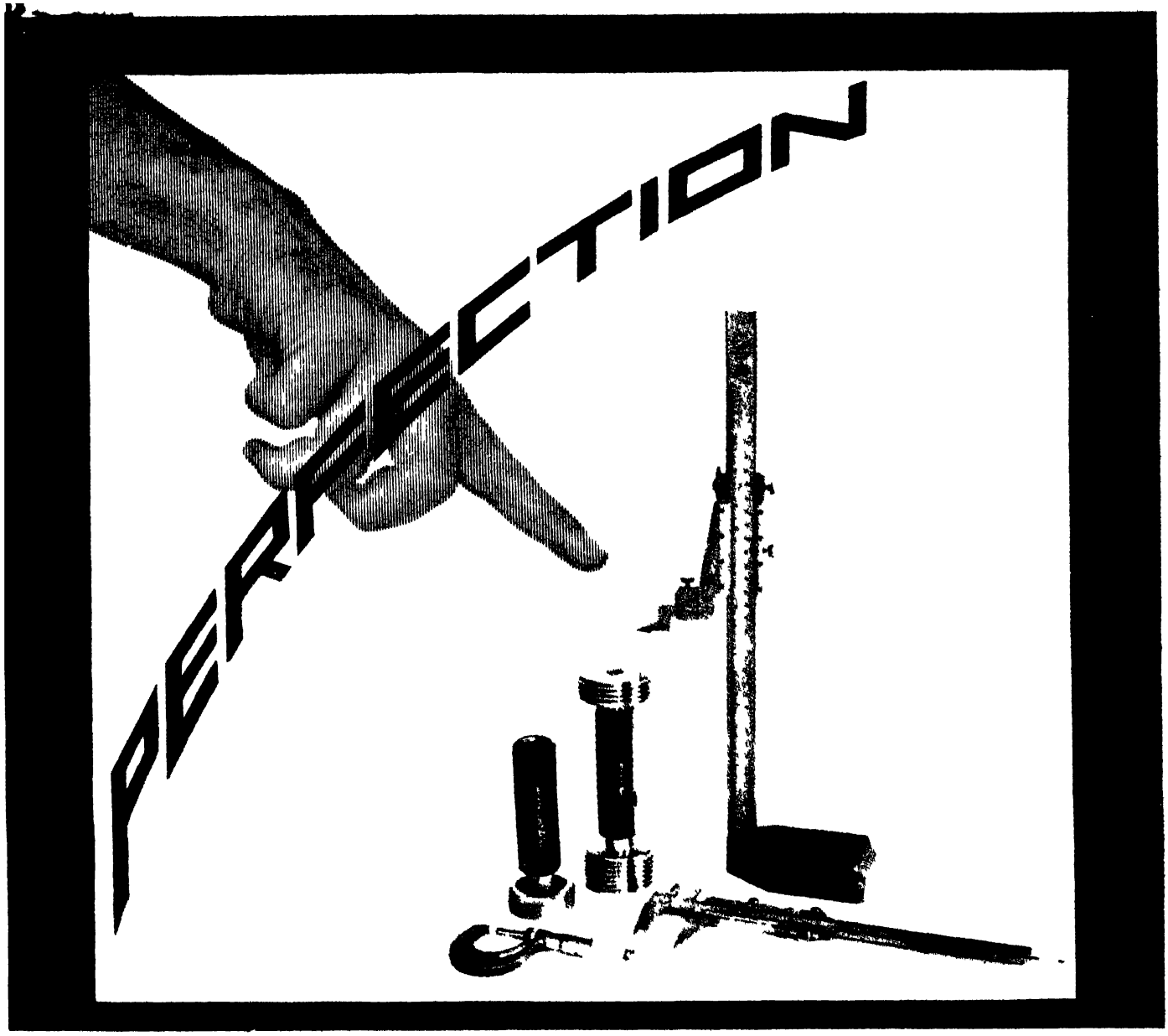
THE LADY Tata Memorial Trust, Bombay, has announced its award of grants and scholarships for 1980-81. They include international awards totalling £ 31,850 and senior and junior scholarships of Rs. 750 and Rs. 500 per month, respectively, for "research work in India on scientific investigations having a bearing on the alleviation of human suffering from disease".

The recipients of the international awards are Dr. H. Bhayani, Department of Biochemistry, St. George's Hospital, London, (£ 4,220) for the investigation of the role of receptor blockade and interferon in tumour growth inhibition; Dr. E. E. Harlow, Department of Molecular Virology, Imperial Cancer Research Fund, London, (£ 3,800) for the study of neo antigens on the surface of virus transformed cells; Dr. B. Azzarone, Institute of Cancerology and Immunogenetics, Villejuif, France, (£ 5,300) for the study of the effect of ionising radiation on cultured fibroblasts from Fanconi's anaemia heterozygotes; Dr. S. Venuta, Memorial Sloan-Kettering Cancer Centre, New York, (£ 6,500) for the study of normal and leukaemic haemopoiesis in continuous human marrow cultures; Dr. A.D. Crockard, M.R.C. Leukaemia Unit, Royal Post-graduate Medical School, London, (£ 7,730) for work on ultrastructural enzyme cytochemistry of Tu and T leukaemias and lymphocytes; and Dr. C. Doyen, Unite des Recherches sur les Maladies du Sang, Catholic University of Louvain, (£ 4,300) for study of myeloid differentiation antigens and use of monoclonal antibodies.

The senior scholarships have been awarded to: Mr. C. Bhaskar, Department of Chemical Technology, University of Bombay, for study on the synthesis of steroidal cyclophosphamides; Mr. D. Chakrabarti, Department of Microbiology, Bose Institute, Calcutta; Mr. T. K. Das, Department of Physiology, University College of Science and Technology, University of Calcutta; Miss T. F. Ashavaid, Biochemistry Laboratories, Jaslok Hospital and Research Centre, Bombay; Mr. S. K. Gupta, Department of Biochemistry, All-India Institute of Medical Sciences, New Delhi; Mr. S. Satish, Department of Biochemistry, All-India Institute of Medical Sciences, New Delhi; and Dr. (Miss) C. Vamsadhara, Department of Pharmacology, Post-graduate Institute of Basic Medical Sciences, University of Madras.

The junior scholarships have been awarded to Miss N. Bhatia, Department of Zoology, Colleges of Science and Technology, University of Calcutta; Dr. A. K. Khare, Department of Orthopaedics, S. N. Medical College, Agra; Miss N. Sengupta, Department of Biochemistry, University College of Science, Calcutta; Miss B. Balsara, Department of Anatomy, Medical College, Nagpur; Mr. G. Das, Biophysics Division, Indian Institute of Experimental Medicine, Calcutta; Mr. A. K. Zaheer, Institute of Medical Sciences, Osmania Medical College, Hyderabad; Mr. S. K. Gupta, Department of Biochemistry, All-India Institute of Medical Sciences, New Delhi; Miss R. Maheshwari, Department of Microbiology, Jawaharlal Nehru Medical College, Aligarh Muslim University, Aligarh; Mr. B. Ramamurthy, Microbiology and Cell Biology Laboratory, Indian Institute of Science, Bangalore; and Miss B. Roy, Department of Physiology, University Colleges of Science and Technology, University of Calcutta.

Besides these, an award of Rs. 300 per month has been made to Mr. B. Henriques of St. Xavier's College, Bombay, for "his special aptitude for research". Mr. Henriques is a B Sc student and is studying redox potential and ion transport across the *E. coli* B membr...



ACCUMEASURES PRECISION MEASURING INSTRUMENTS EMBODY PERFECTION

Manufactured in technical collaboration with P-E Consulting Group, of London, Accumeasures instruments ensure accuracy to the last micron

Accumeasures micrometers, vernier calipers, vernier height gauges and screw plug gauges are :

- manufactured to international standards of accuracy
- properly balanced for easy handling
- corrosion and rough-use resistant
- satin-chrome, no-glare finished, with scales photo-etched and painted jet black
- available in a wide range of sizes

Accumeasures. REACHING FOR PERFECTION

We want more information on Accumeasures instruments Send us the technical literature

Instruments _____

_____

Name _____

Designation _____

Co's Name _____

Address _____

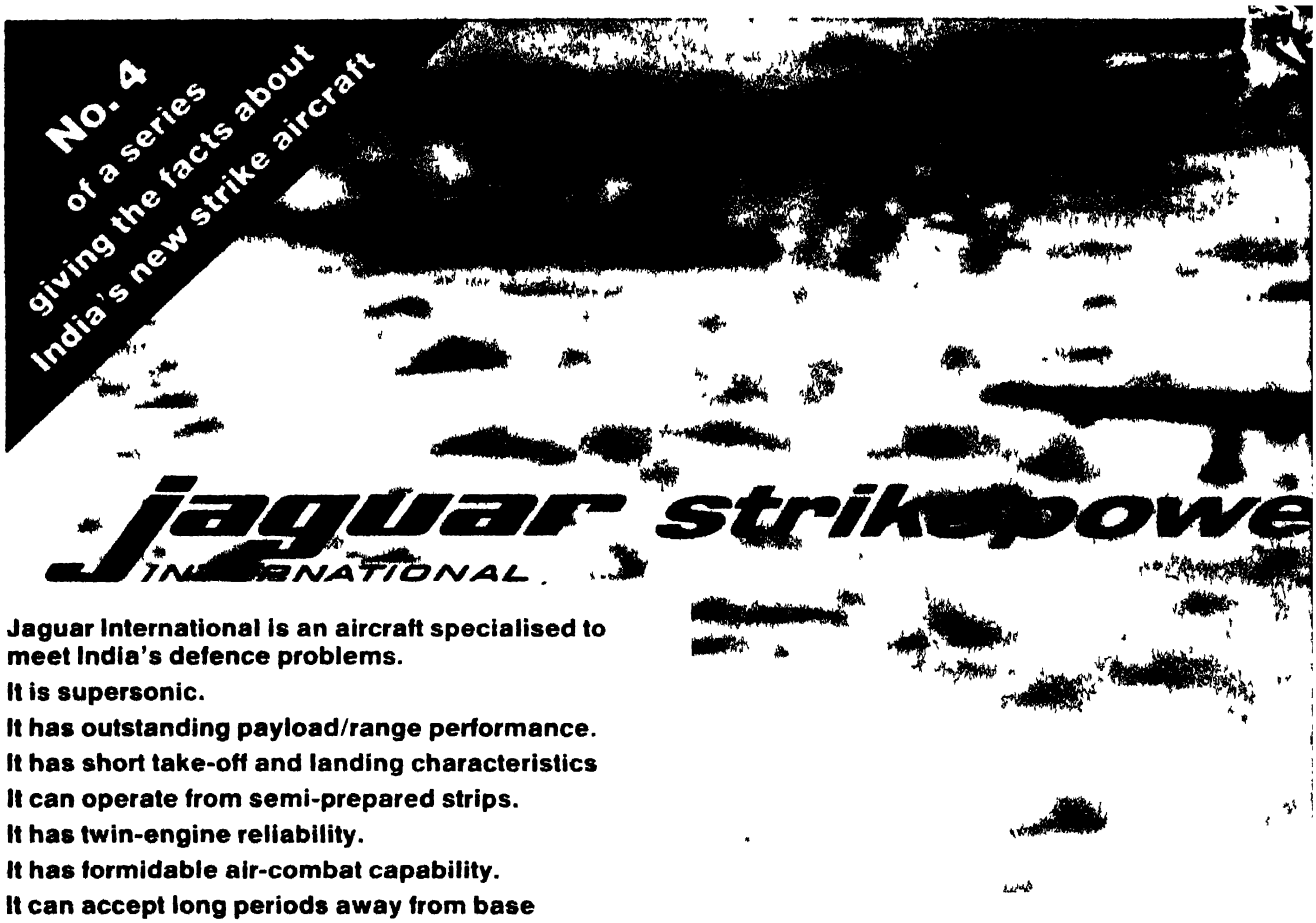
_____

_____

Accumeasures PUNJAB LIMITED

B-75, Phase VII S A S Nagar Mohali Punjab Telephones 87559 87569 87570 Telegram 'PRECISION Telex 38-259 APL IN

national 25/80



Jaguar International is an aircraft specialised to meet India's defence problems.

It is supersonic.

It has outstanding payload/range performance.

It has short take-off and landing characteristics

It can operate from semi-prepared strips.

It has twin-engine reliability.

It has formidable air-combat capability.

It can accept long periods away from base maintenance facilities.

The two-seat version is a first-rate operational trainer which retains full strike capability.

With its combination of supersonic performance, exceptional payload/range capability and outstanding airfield performance Jaguar has set new standards for economical strikepower when operating in support of ground forces in fast-changing battle environments In service with the Royal Air Force, L Armee de l Air, and two other air forces, Jaguar has demonstrated its ability to

- deliver formidable weapon-loads at very high speeds and over considerable ranges
- penetrate sophisticated defences at high speeds and low level
- make one-pass attacks in poor weather conditions with consistent accuracy,
- sustain high mission-rates even from forward bases providing only minimal technical support,
- defend itself against counter-attack in hostile air space

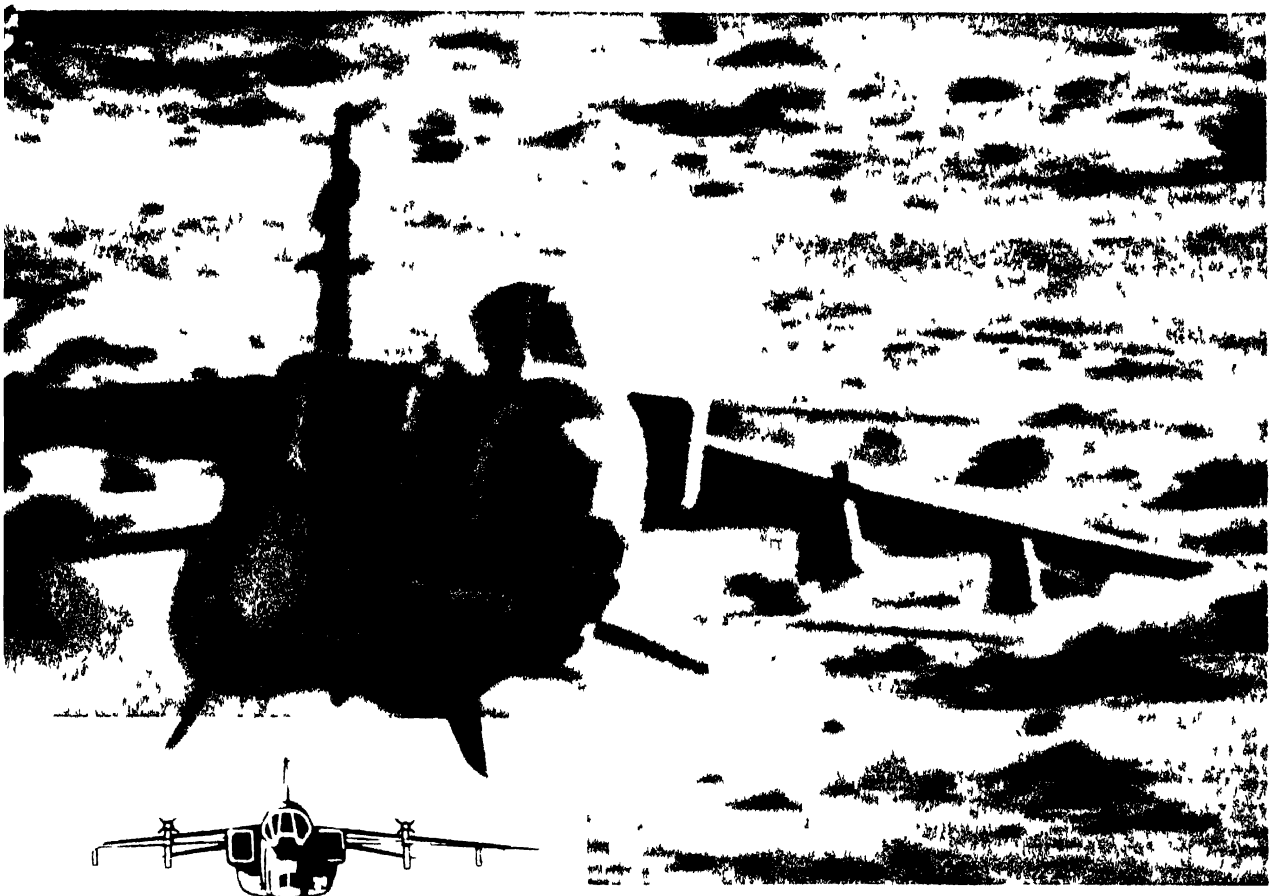
Formidable capability.
Jaguar International has been developed to capitalise on the aircraft s ability to strike with a variety of underwing weapon-loads over a radius of more than 500 statute miles Jaguar has two internally mounted 30 mm guns with 150 rounds per gun and overwing air to air missiles can be fitted to give a potent self-defence capability in hostile environments The two-seat trainer version retains complete strike capability

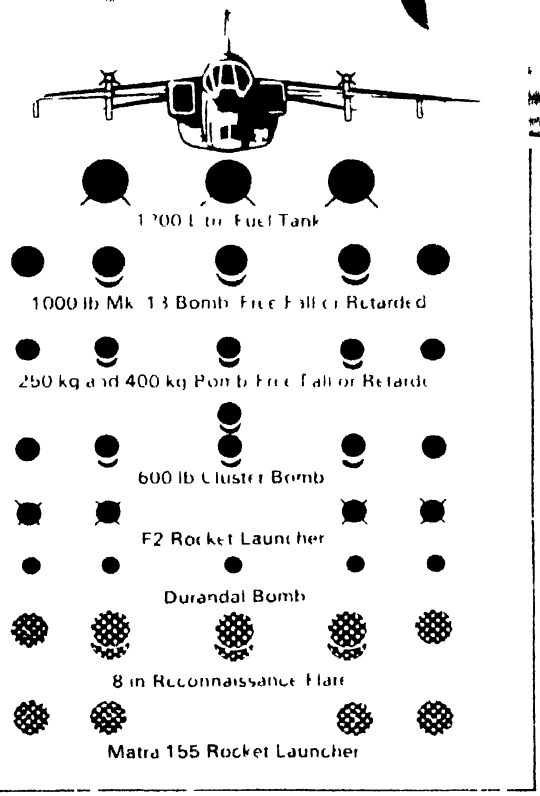
Short runways.
Jaguar can operate from short runways of low bearing-strength with the optimum warload/range mix to suit a wide permutation of tactical requirements Mission profiles can also be suited to specific targets and the strength and composition of the defences At altitude Jaguar International has a speed capability in excess of Mach 1 5 and it is designed for very high speeds at low level Advanced aerodynamic design ensures low gust-response, enabling defences to be penetrated at transonic speeds and at altitudes of 80 metres and less

Fuel tankage.
Internal fuel tankage provides a radius of action at full load of some 350 statute miles on lo-lo-lo tactical missions and over 500 statute miles on hi-lo-hi missions External tankage can be used to increase these ranges, and Jaguar International is capable of a ferry range of well over 2,000 statute miles

Forward airstrips.
With Jaguar operating from forward airstrips, tactical air commanders can mount interdiction and ground support operations over a wide area, extending beyond the immediate combat zone to targets some distance behind the battle line

Nav/attack system.
Jaguar is compatible with nav/attack systems ranging from the simplest to the most sophisticated standards The RAF system, for example, is among the most comprehensive yet applied to a close-support aircraft. At its heart is a navigation and weapon-aiming digital computer, with outputs to a head-up display and





projected map display Feeding into the computer is an inertial platform which makes the system self-contained and provides protection against interference and jamming The RAF s Jaguars have a laser rangefinder and marked target seeker which gives a new order of accuracy to weapon delivery.

Survival ability.
Twin-engine configuration duplicated systems and structural concepts which reduce vulnerability to battle damage give Jaguar excellent survival ability It out-performs other tactical strike aircraft in terms of airfield performance (including ability to operate from unprepared strips), navigation/attack accuracy, and payload/range capability

Development potential.
Moreover, because Jaguar was designed specifically to meet the defence needs of the 1970s and 1980s it has a development potential which is only now beginning to be realised as increased engine thrust and additional weapons options become available Already without superior today, Jaguar International is therefore capable of further development to match developments in the threat of attack

jaguar
INTERNATIONAL

To be developed in India and built by **HINDUSTAN AERONAUTICS LIMITED, BRITISH AEROSPACE & DASSAULT/BREGUET, FRANCE.**

DO YOUR PROFITS GO UP IN SMOKE WITH YOUR SOLVENTS ?

Solvents cost money. When they evaporate, your profits go up in smoke too. Solvent Recovery is a reality plan.

By using an activated carbon Solvent Recovery plant, you can recover your solvents at a fraction of their purchase price —a major saving now and for years ahead.

Ion Exchange India is ready with the best. Backed by technology from Norit of Holland, we can supply you Solvent Recovery plants on a turnkey basis. We will design and build the plant to meet your specific needs and train your personnel to operate it.

Make money out of thin air. Let us help you do it.



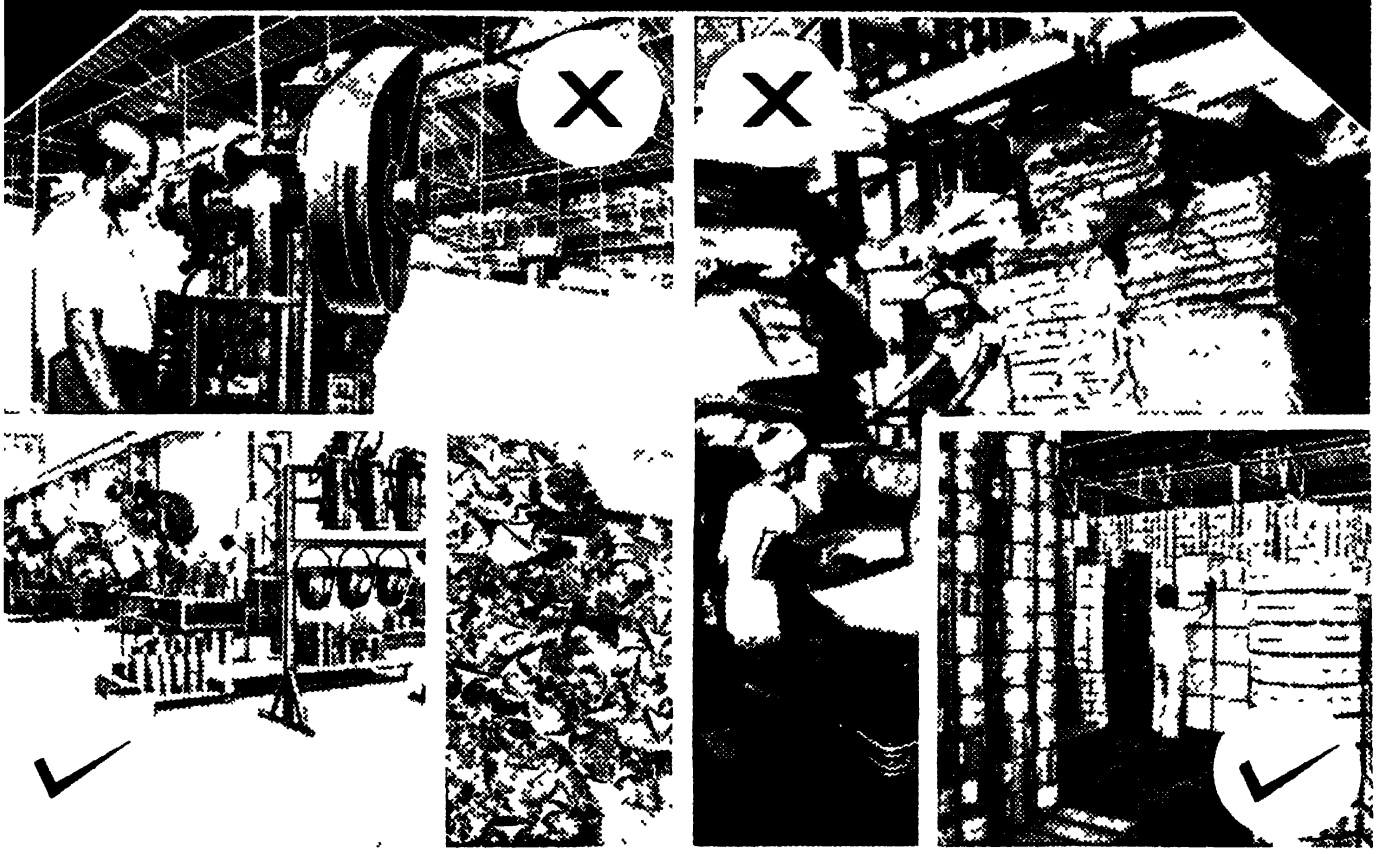
INDION®~ PRODUCTS THAT PAY

ION EXCHANGE (INDIA) LTD.

Tiecicon House, Dr. E Moses Road, Bombay 400 011
Branches: Madras, New Delhi.

802/ R

'Good housekeeping' in a factory is good fire prevention.



Cleanliness and order are basic to fire prevention. Waste, obstructions, badly stored materials—they are all sources of ignition. And a fire in a factory burns more than just the factory. It can destroy your share of the market, your goodwill, irreplaceable equipment and raw material, the livelihoods of your employees. Fight fire before it fights you. Prevent it.

Cut & keep

1. All goods should be stored with aisles between stacks to allow any fire spot to be reached
2. Machinery and surroundings must be clean Heat from machines can ignite oil leaks and cotton waste A newspaper office was burned down recently because of this
3. Oil should leak into drip trays not the floor
4. Dispose sawdust cotton and all other waste in metal cans with lids
5. Do not allow packing materials like paper wood cardboard polyethylene film to be scattered

LPA welcomes your involvement. Please write for details

Fire

Even a small fire can spread fast. Heat in one area brings surrounding areas to their 'flashpoint' and a fire can overwhelm you before you know it. Understand fire— and prevent it.

LPA

अग्नीक्ष अनुसंधान

Prevent fire It can burn you out of business

Loss Prevention Association of India Ltd.

(Sponsored by the general insurance industry)
Warden House Sir P M Road Bombay 400 001

CASLPA 17 254

Krackjack—a national weakness




RUNNIN
THE
aerodynam

While you dream of beautiful days



Clearasil helps you cope with today

Clearasil helps clear and control pimples

to keep young faces pretty



When you get pimples, what you get is a lot of advice.

But the advice that works comes from millions of teenagers all over the world who have been helped by Clearasil. Clearasil... the safe and convenient medication specifically formulated for your pimple problem.

Now it's up to you to get the most from Clearasil to help clear and control your pimples. Here's how:

- **Use Clearasil twice every day, morning and evening.**
- **Apply Clearasil all over your face. Dot a little extra on pimples.**
- **Continue using even after pimples are cleared, because Clearasil mops up excess oil to control pimples.**

Unique 3-way action
Only Clearasil acts in three ways:



1. Opens pimples—special medication helps peel away affected pimple caps

2. Clears pimples—helps pimples to drain without harmful squeezing

3. Dries up pimples—absorbs excess oil to help clear away pimples



Pimples are a part of growing up. All you need is a little patience...and Clearasil.

world's no.1 pimple cream

YOUR CAREER
WHAT PATH IS IT LIKELY TO TAKE?

DO YOU FORESEE STEADY GROWTH IN YOUR INCOME AND PRESTIGE COUPLED WITH REGULAR PROMOTIONS?

LET THE BRITISH INSTITUTES PREPARE YOU FOR CAREER ADVANCEMENT

Not simply because we are the largest correspondence college in the country, not even because we have successfully helped over a million ambitious men and women in shaping their careers but because we have translated our 45 years' expertise into highly professional courses which are specially designed to increase your productivity and prepare you for higher positions—precisely the qualities employers look for.

Choose your course NOW !

D.B.M. (I.M.C.), D.COM. (Bus. Org.), CERT. A.I.I.B., D.COM. (Banking), D.COM (Accounts & I. Tax), D.COM. (Costing), D.COM. (Comp. Sec.), A.C.S. (India), A.I.A.M.,C.A.ENTRANCE, A.M.I.E. (India) A.M.I. Mech. E. (INDIA), A.M.I.I.CHEM E., A.M.Ae.S.I., A.S.E.(LONDON), N.P.C. SUPERVISORS and I.I.T. ENTRANCE EXAMINATIONS

We are recognised as an official training centre for Cert. A.I.I.B. D.Com. (I.M.C.) and D.B.M. (I.M.C.) examinations

COMMERCE:
ACCOUNTANCY, COST ACCOUNTANCY, Banking, Income Tax Practice, Company Secretaryship, Salesmanship, PERSONAL SECRETARYSHIP, Shorthand (Pitman), GOOD ENGLISH, College English, BUSINESS LETTERS, BUSINESS TRAINING, German, French, Russian, Fiction Writing, ARTICLE WRITING, Reporting, Stage, Radio & T.V. Writing, Writing for Children, COMMERCIAL ART, Personality Development

MANAGEMENT:
BUSINESS MANAGEMENT, Sales Management, MARKETING Mgt., Advertising, INDUSTRIAL ADM. Purchase Mgt., Materials Mgt., PERSONNEL MGT., Office Mgt., Management Accountancy, EXPORT MGT. Junior Executive's, MANAGEMENT EXECUTIVE'S, BUSINESS ADMINISTRATION

ENGINEERING:
MECHANICAL ENGG., Mech. Draughtsmanship, CIVIL ENGG., Overseer's (Bldgs. & Roads), ARCHITECTURE, Textile Technology, TEXTILE MANUFACTURE, Computer Programming IBM 360, AUTOCODER PROGRAMMING, Industrial Engg., AUTOMOBILE ENGG., Diesel Engg., ELECTRICAL ENGINEERING & ELECTRONICS, Electrical Supervision, RADIO ENGG., TRANSISTOR ENGINEERING, Television, REFRIGERATION, Chemical Engineering PETROLEUM TECHNOLOGY, Rubber Technology, INDUSTRIAL CHEMISTRY

Tools and Kits supplied for Radio Engg. and Transistor Engg. courses

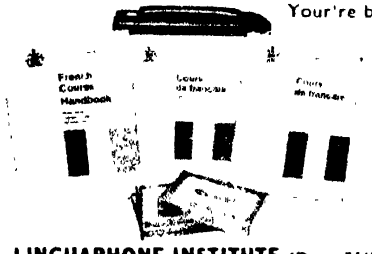
Write today, send coupon, come personally or telephone 256755

THE BRITISH INSTITUTES 56/B17,P.O.Box1025,359,D.N.Road,Bombay 400 023

THE BRITISH INSTITUTES
56/B17, P. O. Box 1025, 359, D. N. Road, Bombay 400 023
Please send me a FREE Prospectus in the SUBJECT
Name Education
Address

People in all walks of life learn to speak any foreign language quickly by LINGUAPHONE





Your're busy and aspiring. And want to reach higher. That's where a new language helps. Within 90 days you can make rapid head-way to success. Its wonderfully easy with Linguaphone to acquire a mastery of any language effortlessly

For full details, of French, German, Polish, Russian, Japanese, Spanish, Persian, Arabic, Chinese (Mandarin), Chinese (Cantonese), Malay, English, Intermediate & Advanced English, Hindi or any of the 38 languages, write today, send coupon or come personally to Linguaphone Institute

LINGUAPHONE INSTITUTE (Dept.56/F17), UCO Bank Building, Flora Fountain, 359, D.N. Road, Bombay-400 023
Demonstration centres at 13/1A, Govt. Place East, Calcutta 13, Daryaganj, New Delhi • 35, Mount Road, Madras

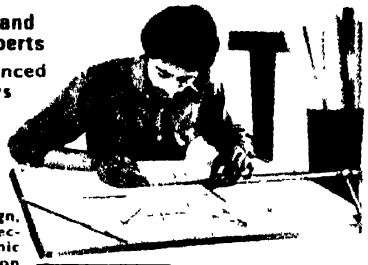
LINGUAPHONE INSTITUTE
56/F17, UCO Bank Building, Flora Fountain, 359, D.N. Road, Bombay-400 023
Please send me a FREE Prospectus for ... (specify language)
Name
Address

THE SUCCESS YOU DESERVE DEPENDS ON YOUR TRAINING

ICS Courses are written and edited by U.K. and U.S.A. experts

ICS, the world's most experienced Correspondence College, offers the widest range of courses—backed by newest techniques and the finest staff

TAKE THE RIGHT COURSE NOW !



ENGINEERING
Architectural Drawing & Design, Civil Engg., Electronic Engg., Electronic Instrumentation, Electronic Technician's, Electrical Engg. Cotton Carding and Spinning, Textile Technology, Textile Mill Supervisor's, Textile Designing, Mechanical Engg., Industrial Instrumentation, Refrigeration & Air-conditioning, Plastic Technology, Radio, Audio & T.V. Servicing, Transistor Radio Servicing, Automobile Engg., Computer Engg., Gas & Electric Welding, Boiler Engg., Civil Draughtsmanship Pulp & Paper Manufacture, Plumbing and Sanitary Engg., Chemical Engg., A.M.I.E. (India) Exam

COMMERCE
Accounting & Auditing, Cost Accountancy, Good English, Advanced English, French, German, Shorthand, Private Secretary's, Public Relations, Store Keeping, Computer Programming, Business Letters, Purchase Officer's, Salesmanship, C.A. Entrance Exam

MANAGEMENT
Business Management, Hotel & Catering Mgt., General Mgt., Industrial Mgt., Personnel Mgt., Marketing Mgt., Catering Management

Also available - Practical Photography, Interior Decoration, Dress Making, Free Lance Journalism, Fine Art

Write today, send coupon come personally or telephone 256755
INTERNATIONAL CORRESPONDENCE SCHOOLS
56/D17 UCO Bank Bldg. Hutatma Chowk, P.O. Box 1931 Bombay 400 023

INTERNATIONAL CORRESPONDENCE SCHOOLS
56/D17, UCO Bank Bldg., Hutatma Chowk, P.O. Box 1931 Bombay 400 023
Please send me a FREE Prospectus in the SUBJECT
Name Education
Address

NORVIC SUN

No. 1
of a series
giving the facts about
India's new strike aircraft

Jaguar
INTERNATIONAL

the pilot's
aircraft

Jaguar International is an aircraft specialised to meet India's defence problems.

It is supersonic.

It has outstanding payload/range performance.

It has short take-off and landing characteristics.

It can operate from unprepared strips.

It has twin-engine reliability.

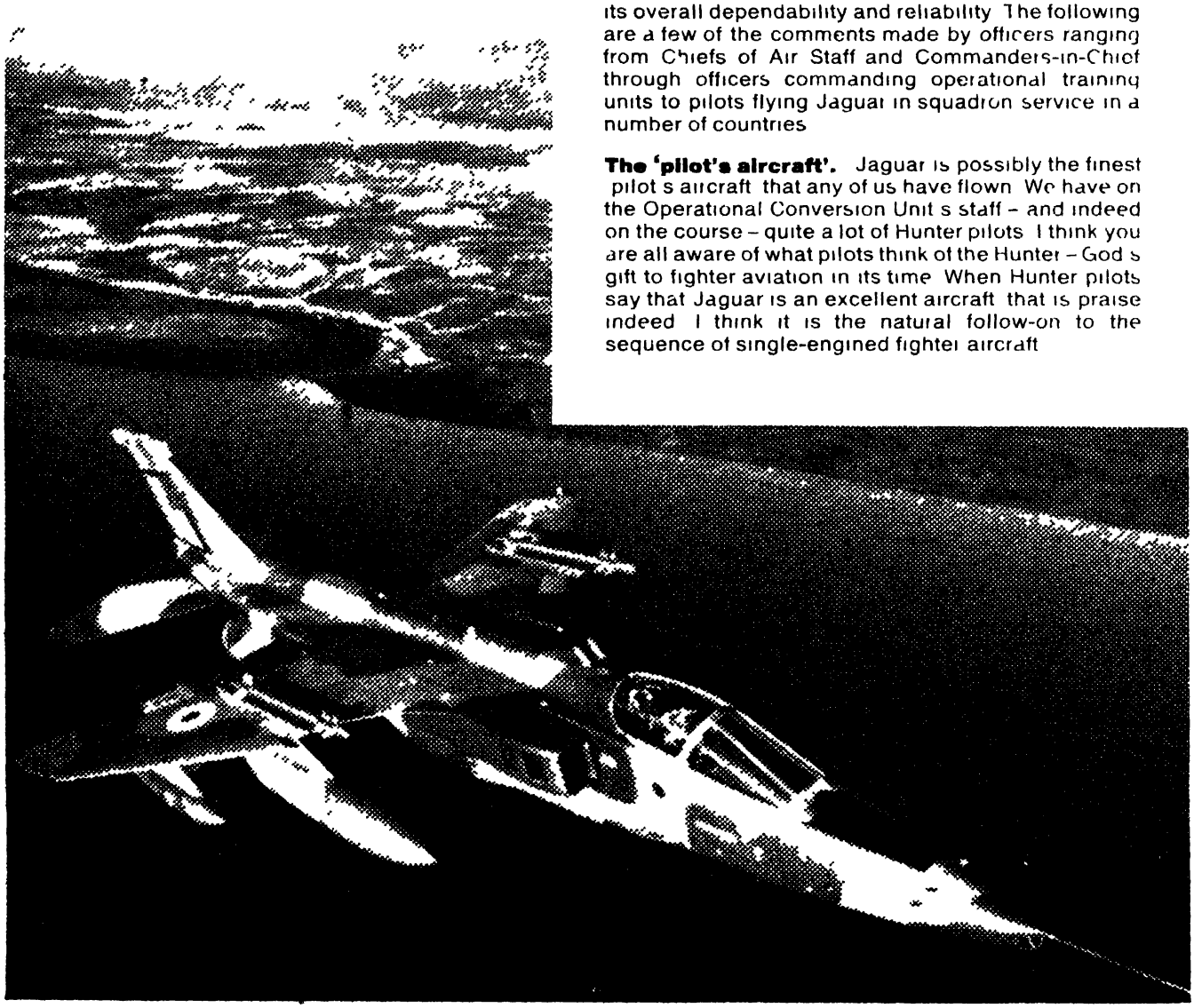
It has formidable air-combat capability.

It can accept long periods away from base maintenance facilities.

The two-seat version is a first-rate operational trainer which retains full strike capability.

Since the days when Jaguar was first flown by pilots of the Royal Air Force and L Armee de l Air it has repeatedly won the highest praise for its handling in the air and on the ground its flying and fighting qualities, its cockpit and systems design, and its overall dependability and reliability The following are a few of the comments made by officers ranging from Chiefs of Air Staff and Commanders-in-Chief through officers commanding operational training units to pilots flying Jaguar in squadron service in a number of countries

The 'pilot's aircraft'. Jaguar is possibly the finest pilot s aircraft that any of us have flown We have on the Operational Conversion Unit s staff – and indeed on the course – quite a lot of Hunter pilots I think you are all aware of what pilots think of the Hunter – God s gift to fighter aviation in its time When Hunter pilots say that Jaguar is an excellent aircraft that is praise indeed I think it is the natural follow-on to the sequence of single-engined fighter aircraft



Work capacity. I have never met anyone who was not agreeably surprised to discover Jaguar s marvell ous performance and the effortless way it helps a squadron do twice as much in half the time

Performance in the air. Everyone – including myself, and I have flown the Jaguar is delighted its performance has come well up to expectations not only in its performance in the air but also on the ground

Low-level flying. Jaguar has a long fatigue life It was laid down on the drawing-board from the start with the low-level environment in mind being built for low-level it handles beautifully at low level

Close-support capability. Jaguar is a doggone good close-support aircraft a good low-altitude medium battle-support airplane or a battlefield interdiction weapon carries a lot of ordnance highly manoeuvrable good acceleration and performance down in the area where it was designed to fight mainly in the low-altitude regions I think it is a very very fine bombing platform and since it is equipped with two 30mm guns it is very effective against armour

Survivability. It would take a very serious and lucky hit to take you completely out of fuel Like the Americans found in Vietnam I think operationally the twin engined aircraft really comes into its own The great survivability factor we feel is that for the first time really we have got an aircraft where you can virtually guarantee on interdiction type targets making the very fast low level straight pass attack This must surely be one of the big aids in keeping yourself in one piece

Combat effectiveness. Jaguar is 20 times as effective as the 600 mph Venom of 25 years ago The modern strike plane is equipped with electronic devices that make the destruction of targets 18 times more certain than was possible 25 years ago We are now in the bomb-in a-bucket era

Rough-field performance. About 1 times the weight of a Hunter, Jaguar can land slower than a Hunter It is quite capable of operating from typical flying club-type grass strips The brake parachute really does pull you up With a lot of low pressure rubber on the runway and high energy absorbing brakes this aircraft can pull up very quickly indeed The big low-pressure tyres and high-energy absorbing undercarriage mean you can touch down on Jaguar without knowing you have touched Nosewheel steering means you can use all the brakes in a cross-wind

Cockpit layout. The designers got the priorities right Everything that matters is right in front of you the pilots like the cockpit it is a very very good fighter cockpit

Radius of action. the aircraft surprised everyone by its radius of action which is almost double that of the present generation of aircraft and is increased still further by its capacity for flight refuelling

Accuracy of attack. If you get your HUD pipper on the target you can hardly fail to deliver your bombs within an effective radius In fact accuracies within 20 ft are common

Safety plus accuracy. Jaguar is one of the safest aircraft the RAF has put into service and for sheer weapon accuracy not many aircraft can take it on '

Weapon platform. A low level high speed Jaguar is an extremely stable weapon aiming platform little affected by turbulence and easily manoeuvred

High sortie rates. Its advanced navigation and attack system put it in the front of strike/attack aircraft in the central region of Europe and its inbuilt ease of maintenance remarkably high serviceability rate mean that it would be capable of very high sortie rates This is a most important factor when NATO air forces would almost certainly be outnumbered in any future conflict

Reliability. it should be a model for future aircraft design It is very very good indeed in terms of redundancy You can lose massive parts of the electrical system and you are still operationally viable

Attack capability. Jaguar has just the kind of attack capability which the French Air Force wanted It is a quite remarkable aircraft at low level and can also perform very well at medium altitude

Nav/attack system. It is designed for operating down low under the weather It has inertial navigation in the case of the British system Doppler radar in the French system It is a very fine weapons delivery platform with good accuracies good manoeuvrability and good performance

Some 400 Jaguars are already in service with the air forces of Britain, France, and two other countries. Now, after one of the longest and most thorough evaluations in aviation history, the Indian Government has decided not only to order Jaguar International but also to develop and build it in India.

jaguar INTERNATIONAL

To be developed and built in India by HINDUSTAN AERONAUTICS LIMITED, BRITISH AEROSPACE & DASSAULT/BREGUET, FRANCE.

A 2500-year old Secret Egyptian Formula that Unlocks the Mysteries of Wealth and Success... The Power Within

A secret formula unwritten until now

Remember the ancient Egyptians and their fabulous wealth? Even today the tombs of the Pharoahs yield spectacular quantities of gold silver diamonds and other precious stones How did they ever amass these incredible riches? The answer is contained in this startlingly powerful 200 page secret formula that AUTOMATICALLY GETS YOU ANYTHING YOU WANT IN LIFE! Money fame success happiness love power they re all yours for the asking providing you know how to work the formula

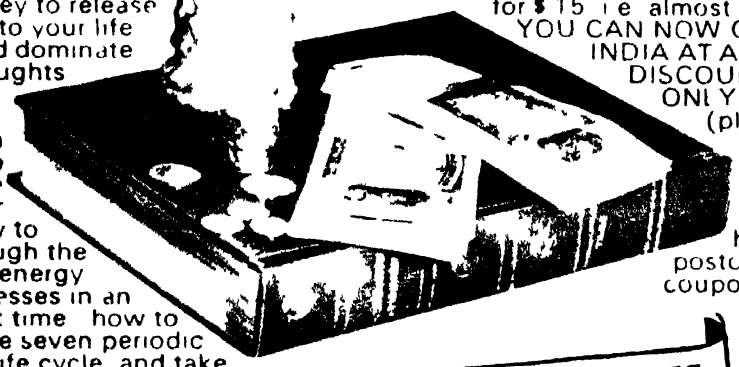
Guaranteed to shake your world

In infinite painstaking detail it tells you how to turn the key to release a flood of riches into your life how to read control and dominate other people s thoughts actions and attitudes how to gain the power used down through the centuries to change and control your own destiny how to heal people through the power of psychic energy and rid yourself of illnesses in an amazingly short time how to understand the seven periodic movements of your life cycle and take full advantage of them all these as well as many other closely guarded ancient secrets hitherto kept under a veil of silence and superstition can now be yours!

Guaranteed to work or you pay nothing

How is it possible that nobody s ever heard of this incredible formula? Don t worry lots of people have Only they ve kept silent about it for obvious reasons King Artaxerxes of Egypt used this formula to attain the pinnacle of power Much later, Napoleon did the same

Today Rockefeller Onassis Jean Paul Getty Howard Hughes—all tremendously successful people who started out very poor in life they are just a few of the people who have used the power of this formula with staggering results NOW YOU CAN TOO! This is the chance you ve been waiting for! This 200 page formula is being sold abroad for $15 i e almost Rs 120/ YOU CAN NOW GET IT IN INDIA AT A SPECIAL DISCOUNT PRICE OF ONLY Rs 43/ (plus Rs 4/- for packing and postage). Stocks are limited So hurry, drop us a postcard or mail the coupon below fast!



MONEY BACK GUARANTEE OFFER

Now Rs.43/- only

The Power Within

Institute of Human Dynamics (Dept ST 8)
3/305, Navjivan Society
Lamington Road Bombay 400008

Please rush me "The Power Within"—the 200 – page Secret Formula of Success under your one week guarantee period I understand if I am not satisfied I can return it within a week to get my money back (less packing & postage)

I will pay postman Rs 47/ (Including Rs 4 - for packing & postage) ST-8

Name _____

Address _____

Save Rs 5/- Please tick
☐ Cheque/I P O for Rs 42/- enclosed
☐ M O for Rs 42/ sent (Same 7-day money back privilege)

Institute of Human Dynamics is a division of Business Development Associates Cheques/I P O.'s/M O 's should be in favour of Business Development Associates.

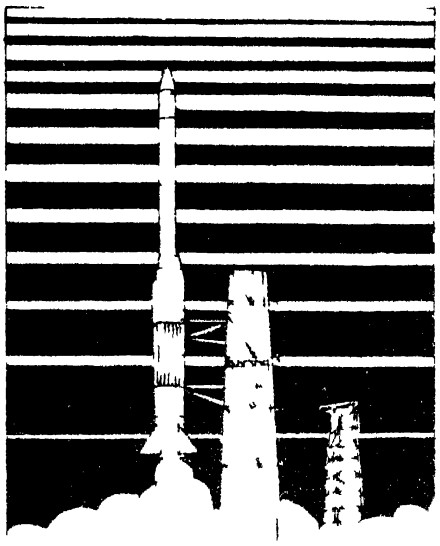
MAIL NO-RISK COUPON TODAY

Science Today

August 1980 Vol 14 No 8

13 India zooms into space
V R Gowariker

In becoming the seventh nation in the world to acquire the rocket launching capability India took shorter time than the other advanced nations to do so earlier



21 Seeing the universe through X-rays
P C Agrawal

Results from the Einstein Orbiting Observatory in less than two years of launching have apparently knocked the bottom out of well established theories



35 Understanding the earth s climate
Shashi K Gupta

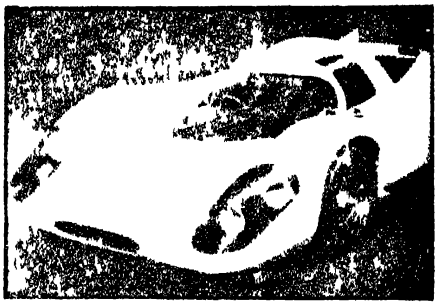
What will the global climate be like in the near future and how do various factors including man s activities affect it?

41 When food bowls turn into fuel farms
Lester R Brown

As world oil production levels off and oil prices climb to dizzy heights more and more countries are beginning to convert their plant crops into power alcohol

48 Vehicle shapes and fuel bills
M M Sivaramakrishnan

The correlation is disconcertingly close when you drive your car fast for long



72 The method of science—8

Science does not claim to provide immediate answers to every question

7 Letters
10 Viewpoints
12 Blurs and Bright Spots
17 Science Shapes Life
30 Round-up of Research
40 This World of Science
40 and of Scientists
55 Books
57 Quiz
61 Ideas and Inventions
63 Another Window
67 Fun with Mathematics
69 If
71 Brain Teasers
71 Awards and Appointments
75 You Too Can Do It

10 The unmaking of a doctor

12 How not to conduct a scientific experiment

57 How much do you know about heredity?

63 The fishermen s problem

69 If the sun had a companion

75 Emergency light



Cover Design Nana Shivalkar

Editor
Surendr Jha

Single copy Rs 2
Subscription 1 year Rs 20
2 years Rs 39 3 years Rs 58

Editorial queries are to be addressed to the Editor SCIENCE TODAY Times of India Building Dr D N Road Bombay 400001 Unsolicited articles must carry adequate return postage

Subscription queries and payments should be addressed to the Circulation Manager SCIENCE TODAY Times of India Building Dr D N Road Bombay 400001

Printed and published for the proprietors Bennett Coleman & Co Ltd by T P Pithavala at Usha Offset Printers Pvt Ltd 125 Govt Industrial Estate Kandivli Bombay 400 067 General Manager Dr Ram S Tarneja Branches 7 Bahadurshah Zafar Marg New Delhi 110 002 139 Ashram Road Ahmedabad 380 009 105/7A S N Banerjee Road Calcutta 700 014 Offices at 13 1 Government Place East Calcutta 700 069 63 Montieth Road Egmore Madras 600 008 407 1 Tirath Bhavan Quarter gate Pune 411 002 26 Station Approach Sudbury Wembley Middlesex London U K London Tel 01 903 9696


Come Alive
with
NESCAFÉ®
Nestlé
NESCAFÉ
instant coffee
Largest selling
instant coffee
in the world
the only instant coffee
made from 100% pure coffee

NS/CAS –2/79

BRAIN DRAIN

ONE CANNOT stop the brain drain all at once (Viewpoints April 1980). The policies and attitudes of our employers and governments have in the past been discriminative to persons who intended to pursue science career. Also the lure for power and perquisites diverted many an able person to leave science and take up a career in administration or business. Only if society improves the lot of our teachers will things change.

A V Jagannadham
Industrial Estate
Ajmer 305 002

TOO TOUGH

SCIENCE TODAY covers many aspects of science and caters to people from all walks of life. This being so, the magazine should publish only articles which are easy to understand. I write in Tamil and intellectual abroad.

I do not understand the article 'A New Synthesis of Alkylene into Ketones' (March 1980, p. 41). I wonder how many readers appreciate this article which being of such a specialised nature could have been left to journals dealing in that particular aspect of science. Such terms as aldehydes must be explained if published in SCIENCE TODAY.

On the other hand, I am sure more features like Science Shapes Life would be welcome. Before its format was changed, SCIENCE TODAY used to carry the words *For Everyman* on the cover. Now the magazine may carry the words *For Polymaths*.

P S By the way polymath means a person of great and diversified learning.

H I Ratin
16 Taylors Road
Madras 600 010

USING 'OTHER METHODS'

SCIENCE or for that matter, all of education in the universities and research institutes, is dying a natural death today and the higher authorities do not care for its survival so long as their vested interests are satisfied. Academic achievements and abilities are totally disregarded in the selection of teachers to the universities and colleges. Sometimes a truly competent biodata is treated as a disqualification for a person throughout his lifetime. Under such a situation sensible human beings adopt other methods of going up and often they do succeed.

Aparna Konar
211 Tagore Park
Delhi 110 007

HOW TO MAKE SCIENCE SURVIVE

THE QUESTION whether science can survive in our older universities ('Viewpoints', March 1980) may depend on a few factors. A large majority of people in our science departments (as probably elsewhere) do little or no work and such persons are treated on a par with the few hard workers when it comes to appointments and promotions. Most promotions are based on seniority (even though posts are formally advertised).

Another serious problem is using teachers trained in branches that were of importance in their younger days. It would be wrong to say that they have no role to play now but one expects that they do not create obstacles in the way of others wishing to modernise.

In fact promotion in many universities is the root cause of frustration and politics. I think that there should be some kind of self promotion scheme which should allow a scientist to get himself evaluated rather than compete with his colleagues. In the new universities, like JNU, the outlook is certainly more modern, and there are better opportunities for interdisciplinary work. However, any good university should continue to attract good students who are their life-line. And, even in JNU the situation may not last long if enough funds are not provided and if jobs are not found for the graduates.

In my own School of Life Sciences we have produced about 35 Ph Ds since 1973. But, sadly *only two* of them could find jobs to their satisfaction in India. The rest have left for universities in the USA and Europe and hardly any one of them wishes to come back. Are we training people to serve the needs of the developed nations?

Sadhir Sopory
Associate Professor
School of Life Sciences
JNU, New Delhi 110 067

PROF MAHESHWARI'S article was indeed an excellent example of the old classic gripe that we sour. The author is no longer chairman of his department in Delhi University and writing such viewpoints seems an expression of his inability to co-operate with his colleagues and eventually create a new department where once again he can enjoy the chair. As an old student of Delhi University who has been associated with it for the past 12 years and having won the best M Sc student's award, I would like to ask: does science teach that baseless ideas should be enforced and recognised just because the idea has come from a person claiming to be a scientist? Surely such a state of affairs has resulted in the gradual departure of several good students.

Such statements by the author as 'there are cheap textbooks written by colleagues or students with unreliable data' or 'publishing papers in substandard journals are unqualified and unwarranted. Science has to be carried on by hard work, perseverance, propagation of fertile ideas, multiplication of resources and above all by absolutely fair dealings'.

Keshav Trehan
Department of Botany
Kurukshetra University
Kurukshetra

PROF MAHESHWARI'S observation that the "most important reason for the deterioration (of university standards) is the unprecedented and unexpected expansion in the number of students" may not appear valid if one takes the example of London University. London University is really an administrative body for processing the examinations given by over a hundred thousand students enrolled in a multitude of colleges which are scattered over the city of London. Surely, in London University, decadence has not set in.

It would be more appropriate to compare Delhi University to London University rather than Harvard or JNU, which are both self-contained campus type universities. But I wholeheartedly agree with Prof Maheshwari when he states that Delhi University has had a rapid unplanned growth. London University, on the other hand, evolved to its present size over the centuries.

B R Pillai
Saraswati Vilas
Trivandrum 695 010

FRUSTRATION OF ICAR SCIENTISTS

THE major causes of mounting frustration among scientists working in the ICAR institutes have been correctly assessed in 'Stem this rot, now!' (View from New Delhi, March 1980). There must indeed be something radically wrong in the functioning of the ICAR when a large number of scientists have found themselves compelled to have recourse to the bothersome, expensive and protracted process of litigation. The ICAR takes refuge behind the make-believe plea of being a registered society which has no statutory status under the government, and is thus exempt from the jurisdiction of law under various articles of the constitution.

I would like to point out that in a recent judgement, dismissing an appeal filed by the managing director of the Uttar Pradesh State Warehousing Corporation, the Supreme Court observed that the employees of statutory

Amazing reports of relief from gum trouble

Two of the many letters Forhan's users write of their own accord.

"Not only cleans teeth, but also has capacity to do away with dental troubles"

" Whenever I myself or any other member of our family suffers from pain in teeth and gums, we apply Forhan's Toothpaste the pain subsides in no time Your Forhan's toothpaste not only cleans teeth but also has capacity to do away with dental troubles "

(Sd/- Deepa Sharad Patwardhan, Bombay)

(Photostats of these and other such letters can be seen at any office of Geoffrey Manners & Co. Ltd.)

"...Helping to possess a sound gum..."

"I have no hesitation to use the superlatives about the quality of Forhan's, an ideal Paste for all, mainly for those who are suffering in gum troubles and with teeth.

In my college life I became a victim of gum troubles but my college physician advised to use the Paste which helped me and still now helping to possess a sound gum "

(Sd - Gour Kishor Chakrabarti, Burdwan)

Take care of your gums with Forhan's, the toothpaste created by a dentist

Dr. Forhan's exclusive formula

The powerful astringent action of Dr Forhan's formula strengthens the gum surface to help you resist gum troubles

Dentists say

Gum troubles can lead to the loss of even healthy teeth. So brush your teeth and massage your gums night and morning with Forhan's Toothpaste and Forhan's Double Action Toothbrush.



Gum troubles lead to health troubles



FREE! " Care of your Gums and Teeth " A colourful, informative booklet on dental care Please write with 25 P stamps for postage, to

Forhan's Dental Advisory Bureau, Post Bag No 11463, Dept T 104-220 Bombay-400 020

Mention the language wanted

Forhan's

the toothpaste created by a dentist

220 F-244

Regd T M Geoffrey Manners & Co. Ltd

bodies owned and managed by the state have "statutory status" The court found hardly any difference between a person directly in government employment and another person employed on a government body or undertaking

An ICAR Scientist

CANCER CURING PLANTS

APROPOS of the item 'Common plant may help treat cancer' (Science Shapes Life, May 1980), two more Indian plants, *Semicarpus anacardium* Linn and *Tylophora indica* (Burm f) Merr deserve mention for their anti-cancer properties The seeds of *Semicarpus anacardium* Linn, a deciduous tree growing in the sub Himalayan region and in the western and central peninsula are widely used as flavouring agents and as a tonic A Bombay physician Dr B G Vad and Dr K J Randive of the Indian Cancer Research Centre Bombay have observed anti cancer properties of oil extracted from nuts of this tree

Anti cancer activity of *Tylophora indica* a twining perennial plant growing along the coastal regions of India have been tested by Dr M P Chitnis *et al* of the Cancer Research Institute Bombay, on two standard transplantable tumours Promising results have been obtained

However, we may fervently hope that further researches of this kind may strengthen the chemotherapeutic method to combat cancer

Joydev Jana
Sub-divisional Controller
(F & S)
Bankura
West Bengal

SILENT VALLEY MUST BE PRESERVED

BY 2000 AD, the requirement of power in Kerala is expected to be about 10,000 million units The net power from all hydroelectric projects—the existing ones and projects which can be executed in the State in the future—will be about 14,000 million units This means, by the year 2020, the State will again be in search of new sources of power

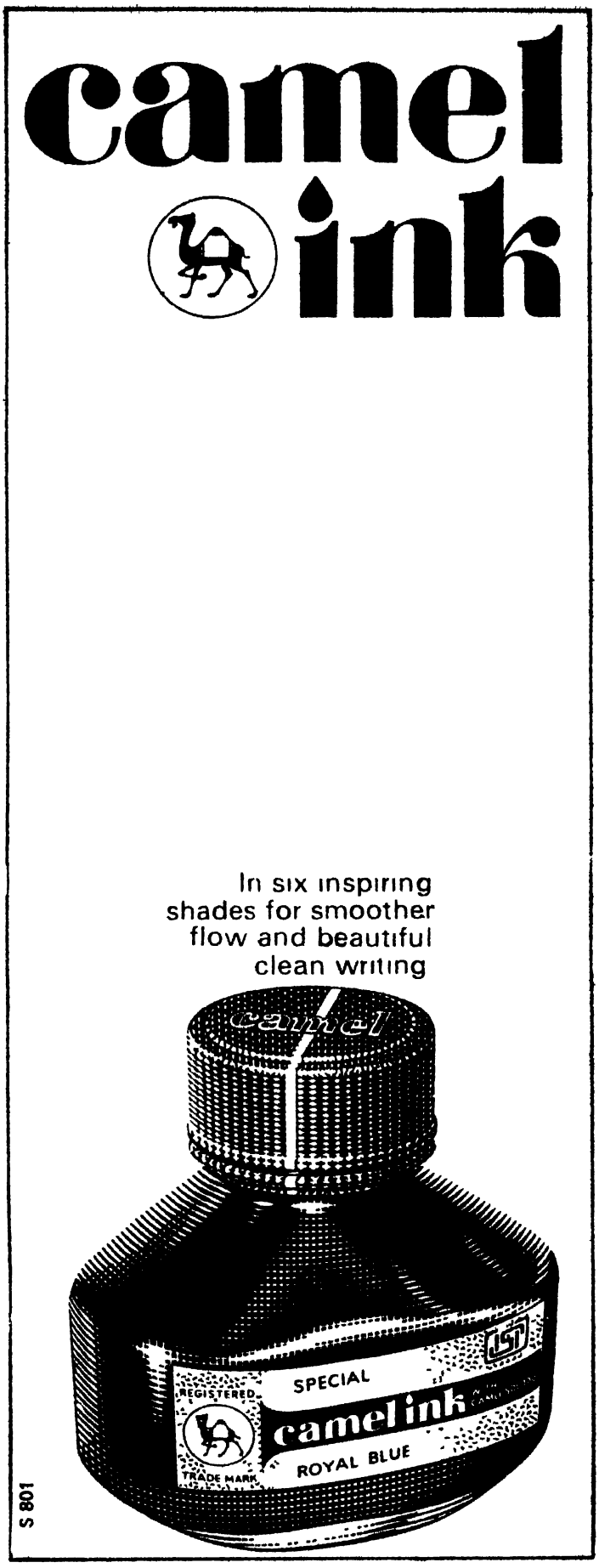
Let us assume that all phases of the Silent Valley power project will be completed by 1990, producing 520 million units At this stage, Kerala's power requirement will be 8000 to 9000 million units For such a small contribution from Silent Valley, we are destroying the five-million-year-old ecosystem! (May 1980)

It is evident that the state's power requirement after 50 years cannot be met by the hydroelectric projects By that time solar energy will be much cheaper than hydel power, and laser fusion may be able to give enormous amounts of power In the early 1940s, nobody even dreamed of the transistor But now the tiny giant has become a must in every walk of life Similarly, the next revolution will be in the field of energy because the research communities of both developed and developing countries are concentrating on finding new and cheaper resources of energy If we want the ancient Silent Valley back after 50 years or so we cannot get it Also, then we may not use hydel power because of the availability of cheaper power from other sources

In the Sixth Five-Year Plan, Rs 16 5 million is allotted for the third phase of the Idukki power project in Kerala This can be completed within two years and that power can be diverted to the Malabar region through a HT line—a 220 KV line now passes through this region from Idukki, carrying power to Karnataka In Palghat and Malappuram districts, it is very convenient to use lift irrigation

The ecosystem in the Silent Valley must be preserved For this, a scheme should be formed so that the Silent Valley, Attappady, New Amarambalam and Kunda forests are isolated and preserved

M K Radhakrishnan
Senior Research Fellow
Department of Physics
University of Cochin
Cochin 682022



The unmaking of a doctor

Culture is activity of thought, and receptiveness to beauty and humane feeling. Scraps of information have nothing to do with it. A merely well-informed man is the most useless bore on God's earth. What we should aim at producing is men who possess both culture and expert knowledge in some special direction.

...Alfred North Whitehead

DESPITE the recommendations of various committees on medical education and the norms laid down by the Medical Council of India, most of the teaching programmes in our country are antiquated. They can do no more than stultify the intellect of the bright-eyed students seeking admission to the portals of medical institutions. Each year in medical school is a water-tight compartment with a final examination which seems to be the main goal of the student. Overladen with inert facts, students are unable to see the wood for the trees. There seems to be little scope for wonderment and discovery. The atmosphere is simply not there. Even an inspired protest against the banality of the system cannot sustain itself against the perils of the dreadful examinations that loom ahead. Small wonder that the medical doctor, the finished product, possesses less than desirable qualities.

The blame for the situation must lie squarely on the medical teachers and the planners of education in the government. Apathy and lack of innovative ideas are among the symptoms of the malaise. The predicament is made worse by the poor financial and other incentives available to medical teachers in this country. When an assistant professor of medicine draws less salary than a typist in a private organisation, is it any wonder that we do not always recruit the very best of available teaching talent? Some of our best people are abroad. What have we done about the brain drain? The men who make the policies seem to show little genuine concern.

Take a look at the educational process itself. The beginning years in the medical college consist of studies in anatomy, physiology and biochemistry. There is no contact with clinical material. In fact, there is an almost total lack of integration with the clinical sciences. Professors in the basic sciences are almost cut off from the clinical disciplines, and, vice versa, clinical teachers remain happily ignorant of the advances in the basic sciences. The result is that the student keeps on learning a series of unconnected facts—some of them very dull and boring.

In such a milieu, it is hardly surprising that there is any research activity that merits attention. In every class there are a handful of students who are keen to go beyond the curriculum and do some investigatory work themselves. Alas, Medical College labs simply do not provide any amenities for research. It is not that most of them are poorly equipped. There is just no time allotted for research. There are endless lectures, tutorials, clinics and seminars. There is no elective programme for laboratory work. "Do not ask any brilliant questions. You might even fail in your exams"—so the seniors seem to say. The sad state of affairs persists even in the postgraduate years when the student is expected to produce a thesis under the supervision of a guide. Most of the theses are churned out in a perfunctory manner. Usually, they are badly re-hashed versions of other people's work in bad English. The situation is indeed banal. The factories must continue to churn out their undergraduates and postgraduates. Who are we to ask these institutions if any original research work is being carried out?

There is a solution to this problem, as we discovered in some of the American universities. Teachers at various levels are given joint appointments in more than one department. Surgeons could be given a joint appointment in the department of anatomy. Teachers of medicine could similarly hold joint appointments in physiology, biochemistry or pharmacology. Teachers in the basic sciences should also participate in clinical programmes—not only in the seminars and conferences but also at the bedside clinics and outpatient department. This is the only way to prevent fossilisation which affects professors in isolation.

Preceptor system

At the first glance it may seem excessive to ask teachers in the basic sciences to participate in OPD clinics. However, if a couple of the younger teachers from the basic science faculty spend even an hour in the OPD, it can greatly relieve the tremendous overcrowding found in the OPD clinics of every medical institution. In turn, they would see a wealth of clinical material from which they are presently isolated. Further, the students would have a rare chance of having a joint conference in the OPD clinic with teachers from two or more connected disciplines. For example, suppose a patient with a hand injury walks into the surgical OPD. The surgeon could discuss the case with the lecturer in anatomy, this would make the subject all the more interesting. Or, the anatomy and physiology of the digestive system can be made more interesting to students by a barium meal and an endoscopic demonstration. While teaching in the medical wards, I have often invited one of the professors of pharmacology to discuss the medical management of the patient. Such an interdisciplinary get-together should be frequent—not merely an inspiration of the moment.

In any teaching system, the student must remain deeply involved. To encourage this, there must be seminars organised by the students themselves in addition to lectures and bedside clinics. Small groups of students could be assigned preceptors from the rank of lecturers and assistant professors. Under the guidance of the preceptor they could prepare a subject for a seminar. As students from different clinical units present their seminars before their teachers a sense of confidence and responsibility would be created. There would also be an air of healthy competition. Finally, this could become one of the major avenues by which students would learn how to present their scientific material. They would also learn how to look up references and how to use a library.

The preceptor system has an added advantage. The preceptor comes to know his students more intimately. A student may be having problems that he is unwilling to talk about with his senior professor. A junior preceptor (lecturer or assistant professor) is a good person to talk to about one's difficulties in a medical college.



Indeed, many students need someone to talk to about their psychological problems The junior preceptor becomes his friend, philosopher and guide Such a student-preceptor relationship should be encouraged from the very first day in a medical college

Assessment of student performance has to be a continuous process In some universities the practice of sessional marking has come into vogue A certain percentage of the final marks is reserved for the day-to-day performance In particular, credit is specially given for practical procedures learnt in the wards or laboratories Periodic tests, drawn from a question-bank of multiple-choice questions, can also be a very effective way of assessment Although there may be a tendency among rival institutions to boost up the sessional marks of their own students, the benefits of the system cannot be denied After all, any system can be abused It is up to the deans and the vice-chancellor of the university to keep a vigilant eye on the system

Help must be readily available to the underprivileged Many of the scheduled caste and backward classes students have a language problem They should be given the choice of attending special coaching classes in English during the vacation period Regrettably, little has been in this direction so far The result is that a fair number of our medical teachers themselves fumble for words when teaching their subjects And, what could they possibly grasp from the vast medical literature which is in English? I have no desire to enter into any language controversy over here

I now come to the internship period This is one of the most confused periods in a student's life—confused, because the very goals of the internship are vague We have shirked the answer to the question do we want our doctors to be familiar with rural conditions and make it a compulsory aspect of national service? Except for a few well-organised programmes in the country, internship is a wasteland It is also a period when the once bright and inspired student is frustrated to a point when he thinks seriously of taking the FCFMS and VQE examinations from the USA for the inevitable migration He is getting ready for export The routine is all too familiar—recommendation letters air-tickets to Manila, Nairobi or other examination centres and the passport application with all its hassles It is during this period that the student loses touch with practical medicine, for his mind is directed elsewhere

The time has come to give a serious thought to this problem Medical education is relatively inexpensive because it is supported by the state government in India The government has therefore every right in expecting the beneficiary of the medical education to give a year of national service to his country If China can bring about a big change in its health programme by compulsory national service, why cannot India do so? Till this is done, the question will always be asked is the medical education you get suited to the needs of the country? If more than two-thirds of our medical graduates from the leading institutions are in the process of migrating abroad we already have the answer Clearly, our goals need to be reset Pious thoughts, flatulent words and windy resolutions are of no value A radical governmental decision is necessary After all, every country gets the medicine it deserves—in more ways than one

K G NAIR

Dr Nair is an honorary senior cardiologist at Jaslok Hospital Bombay Prior to this appointment he was professor-director of medicine and head of the Department of Cardiology at the K E M Hospital, Bombay He has held teaching appointments in the USA at the Universities of Harward Chicago and Pennsylvania, and was also a visiting scientist at the National Institute of Medical Research, London

Don't let a cold ruin your day.



A cold can be relieved

There is a way to relieve a runny nose or blocked nose, heavy head, sore throat and chest congestion—all those symptoms that can spoil the best of days

Fight it with a colds remedy

It's not enough to treat it like you would treat any other ailment Use a special colds medicine that works simultaneously on all affected areas

Coldarin is only for colds

Coldarin relieves all the symptoms that bring you down It has special ingredients that act together against all cold-affected areas. Plus Vitamin C to build your resistance When you have a cold, it makes sense to treat it like a cold



COLDARIN

Specially formulated for colds

CASBC 64 242

How not to conduct a scientific experiment

A TOTAL eclipse of the sun provides an opportunity to study in great detail the sun's external layers, usually invisible in the brilliant glare. This is of great interest to astronomers and astrophysicists. The value of such observations is lucidly described by Prof. M. K.V. Bappu in SCIENCE TODAY, February 1980.

The unusual masking of the sun also affects plants and animals. Plants that close up after sunset do so during the eclipse, too. "Pigeons go to roost, owls and bats come out of hiding and cocks may crow." Personally I do not believe there is a great deal to be learnt by observing such effects. None of it is surprising, and similar behaviour might be evoked by a sudden cloudy patch before the sun. Other than the fairly obvious, and perhaps some not so obvious ways in which changes in daylight or temperature might affect plants and animals, there is not much to be gained from such observations. Yet there is a thriving lore consisting of real and supposed effects of solar eclipse on living organisms, which seems to attract scientists.

The eclipse of 16 February 1980 generated a spate of reports on this subject. I have before me a file of news items describing terrestrial effects of solar eclipse and numerous letters and articles sent to SCIENCE TODAY Most claim to be the results of "scientific investigations". A good scientific experiment is designed to test a specific hypothesis and its result either strengthens the hypothesis or excludes it. What if the hypothesis in question is a fear or a superstition? The results of such experiments seem to invariably follow the attitude of the experimenter. Experiments and observations inspired by prejudices and apprehensions are just as likely as not to confirm these in the minds of the observer. This last point is amply borne out by the material before me. The following UNI report on 12 February illustrates the fearful state of mind in which a credulous observer of the eclipse might approach this phenomenon.

"Astro-Tantrik Ramesh Chandra Bhattacharya, President of the All India Astrological and Astronomical Society (AIAAS), said that natural calamities, including earthquake and deluge, imperil different parts of the world as the aftermath of the solar eclipse.

"A permanent president, of the Varanasi Pandit Mahasabha, Mr. Bhattacharya told UNI that India's south, north and north-eastern parts might be rocked by earthquakes followed by storm and heavy floods .... the aftermath of the eclipse might trigger off political conflicts and unstability in the country besides bloodshed. He said that the effect of the solar eclipse would remain operative for 14 years and the first seven and a half years might be a phase of turmoil and trauma. Under its influence, different diseases, specially those relating to lung cancer and asthma, might be pronounced."

Mr. N. K. Agarwal, an engineer working on a new theory of earthquake prediction based on planetary movements, sent to the *Times of India* the following rules enjoined by Hindu scriptures:

1. A man should not eat for a few hours before or after the eclipse.
2. A man should take bath in a river during the eclipse.
3. A man not able to take bath in a river should remain indoor and should not be exposed to radiation during the eclipse. A pregnant lady should strictly observe this rule.
4. Prayer meetings should take place on the river banks during the eclipse.
5. Needy and disabled people should be helped.
6. Cooked food, exposed to radiation of the eclipse, should not be taken.

Mr. Agarwal believes these rules are meant to protect mankind from "some type of waves" coming to the earth and this matter needs investigation. On his own theory, a solar eclipse is normally preceded or followed by a major earthquake. It is quite possible, according to Mr. Agarwal, that our ancestors knew about this and they laid down the rule about going to riverbanks to attract masses to open areas. "A man taking bath will be naturally protected from injurious waves coming out at the time of the eclipse and fasting was advised probably to keep the masses active and face any eventuality that might arise."

The bit about the pregnant lady in rule 3 is not an aside. It is widely believed that pregnant women are specially endangered by the eclipse. Darryl D'Monte of the *Indian Express* interviewed a number of gynaecologists. He found that eminent medical men are about evenly divided on this issue. According to a well-known Bombay gynaecologist, the eclipse could harm a pregnant woman, particularly during the first ten weeks of pregnancy. The gynaecologist had an explanation:

"The radiation from the sun during the eclipse is not direct and the different strata between the sun and the earth get highly ionised. This is particularly so for the layer directly in contact with the earth. The net result is that the rays emitted are deep penetrating ones, like gamma rays, and can penetrate the uterus and harm the foetus."

The effect of the solar eclipse on the earth's atmosphere are described in an article by Dr. A. P. Mitra in SCIENCE TODAY, February 1980. The eclipse rather drastically cuts down ionising radiations from the sun. Clearly, the eminent gynaecologist did not check up on the physics implied by his theory.

A wild-life warden at Udaipur Zoo wrote to say that he had carefully observed the effect of the eclipse on pregnant females of four different species: neelgai, spotted deer, hare and guinea pigs. There were no effects. "All pregnant animals littered normally and the litters were perfectly healthy." The warden also studied the behaviour of 33 species of birds and mammals during the eclipse and found no change in general behaviour. He noticed that "the animals enjoyed their food during the eclipse".

A scientist at the All-India Institute of Medical Sciences in New Delhi examined the effects of the eclipse on the cardiovascular system. He measured heart-beat and blood-pressure in 74 subjects, including foetal heart-beat in two pregnant women, and found no significant effect on any of the parameters. In a few persons, the heart-beat and blood-pressure went up a little just before the eclipse and went down just after it, an effect attributable to the expectation that "something is going to happen" and a relaxation after the event. Somewhat similar results were obtained in a study of 38 patients in Kohima but these are described in a press report as "significant changes in the nervous system".

A 20-member medical team in Bangalore announced their plans to conduct intelligence tests "on a group of youths to find out whether the intellectual level of human beings was affected during the period of eclipse". This particular experiment was undertaken because "it was customary to initiate young students in Vedic studies on an eclipse day". The Bangalore doctors also planned to study the gastric secretions of people in the hope that this might throw light

Contd. on p. 16

India zooms into space

Vasant R. Gowariker

From almost toy rocketry to satellite-launching took just about ten years

THE year 1969 marked the maiden flight of an India-made rocket, using indigenously manufactured propellants. The rocket weighed 10 kg. On 18 July, 1980, India launched Satellite Launching Vehicle-3 (SLV-3), another rocket developed by the Vikram Sarabhai Space Centre (VSSC) at Trivandrum. Its weight was 17,000 kg. Between the two rocket flights is woven the fascinating story of the growth of Indian rocketry, from almost a toy rocketry era to the day India propelled herself into the space age. India has now become the seventh nation in the world to attain a satellite-launching capability.

The advances in Indian rocketry are not just in terms of the rocket weight. From a single-stage, unguided rocket, India has advanced to a four-stage fully controlled and guided rocket in just about 10 years.



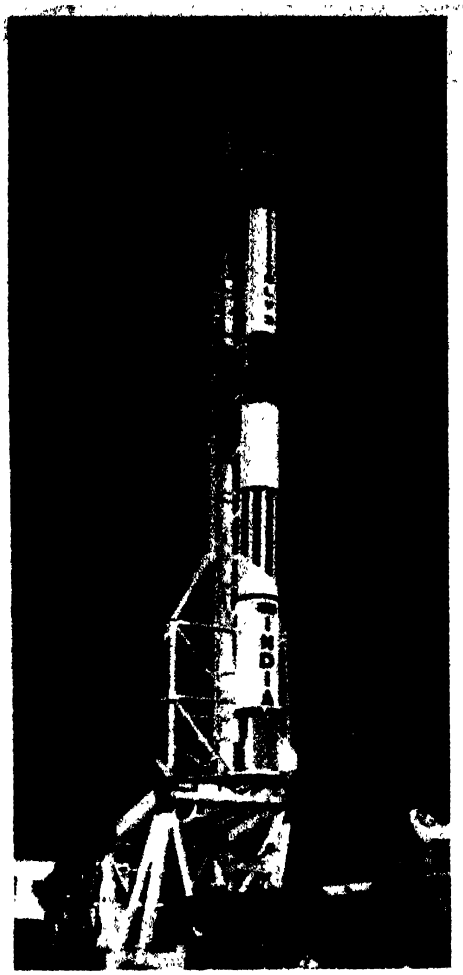
The flight of the 1969 Thumba-made rocket using indigenously manufactured propellants

How does this time period compare with that of the other advanced nations? The comparison is difficult for a variety of reasons but if one merely considers the time span, India perhaps took lesser time than some of the other six nations. If one also considers that the industrial infrastructure of these seven countries was already quite developed even when they were in the toy rocketry era, India comes out even better in comparison.

India followed her own path in her own characteristic way to reach this goal. Even while tinkering with a tiny rocket, the Indian Space Research Organisation (ISRO) scientists and engineers were equipping themselves mentally with the rudiments of a satellite launch vehicle. They kept the environment around them unpolluted by any undue conventionalism in their technology perusal efforts. From scratch, ISRO planned and created the infra-structural facilities and laboratories for research, development, testing and fabrication. It had a clear-cut objective before it: the technological pathway through meteorological and sounding rockets must lead to the development of launchers and to the capability of launching communication satellites. That was indeed a dream when the rocket was fired in 1969; it reached a peak altitude of only 4.2 km!

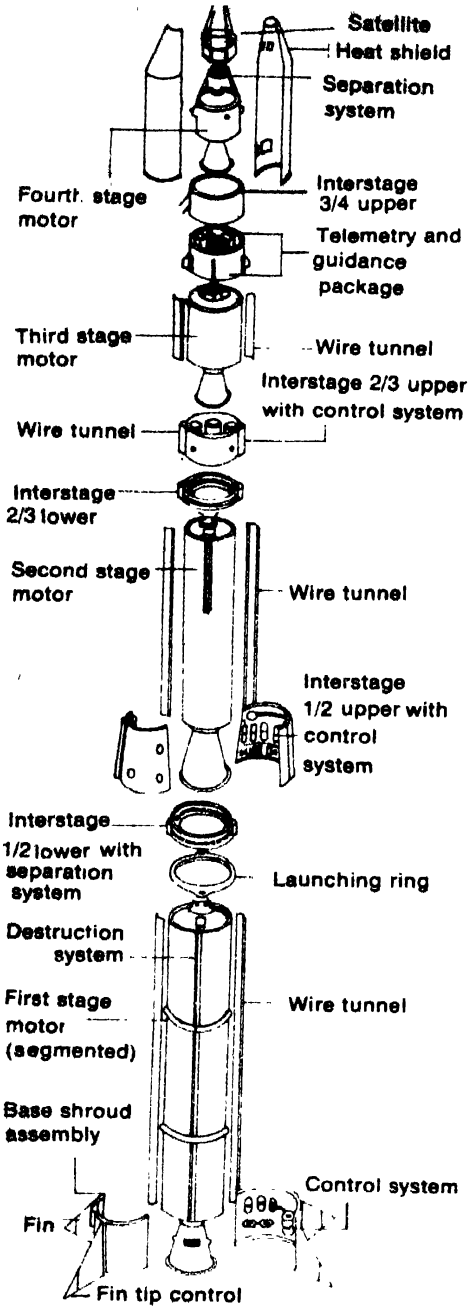
The USSR, USA, France—all had long experience in rocketry on an operational and commensurate scale which could be brought to bear on building launch vehicles. Unlike them, India hardly had any rocket base. When the USA, for instance, decided to launch its first satellite (Explorer 1), it already had rocket motors, control and guidance systems readily available to build the Juno-1 launch vehicle. Similarly, when Britain finally launched her first satellite (after several failures) in October 1971, she already had the Black Knight rocket used for warhead re-entry studies. Black Arrow , as the launch vehicle, was merely adapted from Black Knight.

After the historical launch of the Sputnik in 1957, France took eight years to orbit her first satellite (Asterix-1, weighing 42 kg). Japan launched Ousumi, weighing 23.6 kg, by the Lamda 4 S-5 rocket in February 1970. However, the Japanese efforts were preceded by 15 years of work in rocketry. Japan was roughly at the same level in rocketry in the mid-50's as India was in the late-60's to early-70's. India, then, has crossed these marks in a little over 10 years.



The 1980 4-stage SLV-3 being checked out vertically on its launcher

SLV-3 has clearly demonstrated what the country is capable of doing in advanced and sophisticated technology areas. It was conceived designed and developed entirely by the young engineers and technologists of the VSSC, which is the largest of the ISRO centres for research and development work. The Aryabhata, Bhaskara and now RS-1 (Rohini Satellite-1) have shown the maturing of the ISRO technology at the Satellite Centre at Bangalore. SLV-3 was launched from ISRO's SHAR Centre at Sriharikota in Andhra Pradesh which also provided support in telemetry, tracking, telecommand and real-time systems for launch and post-launch operations. The SLV-3 project team of the VSSC integrated the entire vehicle and the satellite. The Space Application Centre (SAC), Ahmedabad,



An exploded view of SLV-3

provided the S-band tracking system for the down-range station to track the vehicle and receive telemetry data, the telemetry antenna and the closed-circuit TV system for SHAR

Anatomy of SLV-3

SLV-3 is a four-stage vehicle employing solid prepellants in all the stages. It is 22 metres long and weighs about seven tons. The first two stages are made of 15 CDV 6 steel, while the last two stages are made of fibre-reinforced plastic. All the four stages are interconnected by the aluminium alloy interstage which houses the instrumentation, control system and separation system. The first three stages are provided with destruction systems, which are brought into operation by telecommand in case of any abnormal deviation of the vehicle from the predicted trajectory.

The first stage rocket motor is one metre and the fourth and last stage is 65 cm in diameter. The second and third stages have a diameter of 80 cm each. The first two stages employ nine and three tons, respectively, of polybutadiene-based propellant. The first stage develops an average thrust of 45 tons and the second stage develops an average thrust of 20 tons controlled by a bipropellant reaction control system. The last two stages use about one ton and 250 kg of functionally terminated polybutadiene propellant, respectively. The third stage develops an average thrust of about 6.5 tons controlled by a monopropellant reaction system while the fourth and last stage develops an average thrust of 2.4 tons and is spin stabilised.

The equipment bay which houses guidance and control electronics, telemetry, telecommand, transponder and tone range systems is located in the lower half of the interstage between the third and fourth stages (see figure). The Rohini Satellite (RS-1) atop the fourth stage contains instrumentation to determine the fourth stage performance data, injection and orbital parameters. RS-1 and the fourth stage are protected from aerodynamic and thermal loads during the ascend phase up to 75 km by a fibreglass honey-comb heat shield.

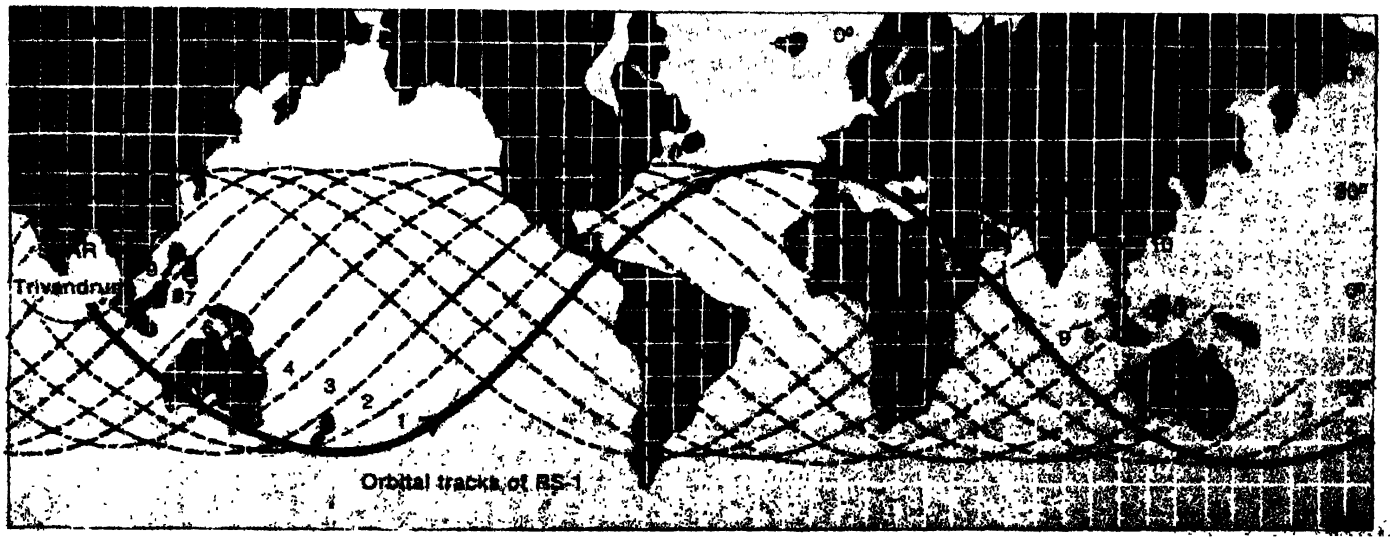
New and interesting features

The launcher technology conceived and realised in SLV-3 has some novel and interesting features. The bipropellant reaction motors for the stage-2 control system were employed only in experimental systems and are not common in launch vehicles. The system uses red fuming nitric acid and hydrazine as the propellant combination, capable of generating three different thrust ratings (250 kg, 50 kg and 10 kg) by a suitable combination of 12 thrusters.

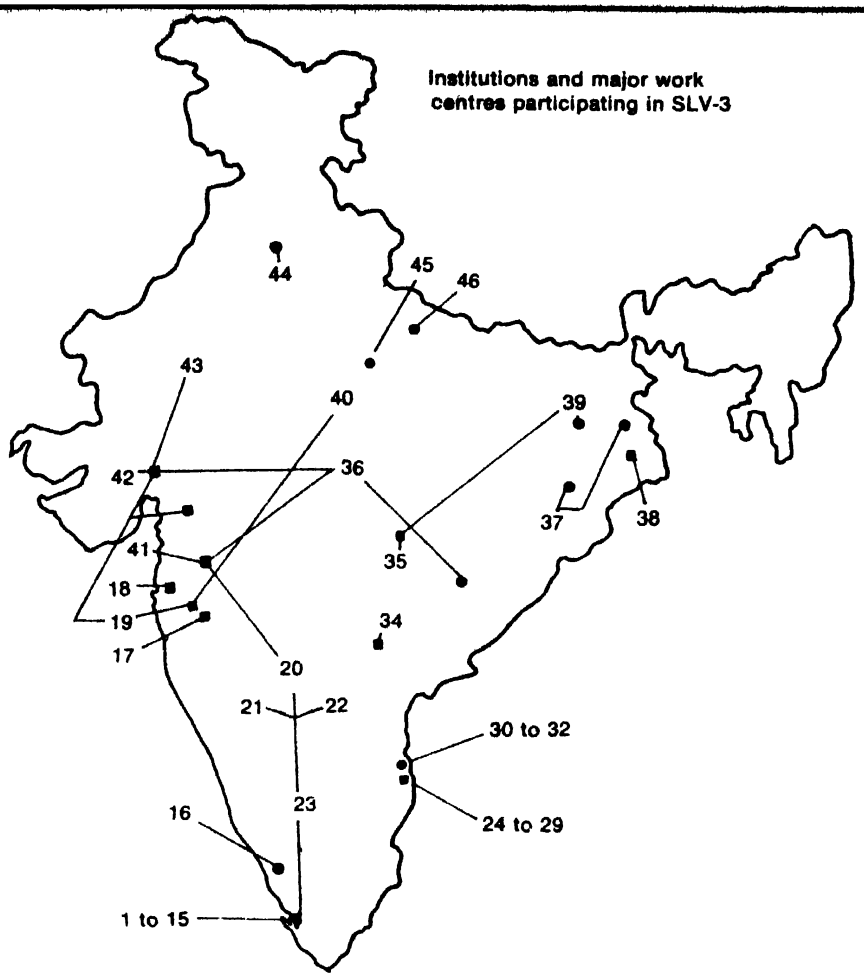
The hydrazine motors in S-3 control systems have been used previously for satellite propulsion systems elsewhere, but are not commonly used for launch vehicle control systems. The system employs over 99 per cent pure hydrazine and uses an indigenously developed catalyst. Three different thrust ratings (25 kg, 5 kg and 1 kg) are employed.

The launch vehicle also has a decentralised pulse code modulation (PCM) unit making use of a remote multiplexing and encoding unit (RMEU) and a central control unit. This system, used by advanced vehicles, collects sensor and instrumentation data from individual stages transmitted through a central transmitter.

The control sharing between the fin tip control system and the secondary injection thrust vector control (SITVC) employed in SLV-3 is something of an unorthodox feature. During the first 17 seconds of the flight from lift-off, SITVC is active and subsequently it



Orbital tracks of RS-1



No.	Subsystems/Components	Work Centre
1 to 15	Vehicle subsystems	VSSC, Trivandrum
16	Gyrocomponents	HMT, Kalamassery
17	Mandrels	Cooper, Satara
18	Rocket motor hardware	L & T., Bombay
19	—do—	WIL, Walchandnagar
20 to 22	Interstages, fasteners	HAL, Bangalore
23	End domes, winding mandrels	Everest, Venkateswara, Coimbatore
24 to 29	Transporter, fixtures	Prabhakar Products, Madras
30 to 32	Propellant production, static tests, flight tests	SHAR
33	Proof motors	BHPV, Vishakhapatnam
34	Forgings	RFC, Hyderabad
35	Insulation moulding	BHEL, Bhopal
36	Rocket motor cases	HAL, Nasik &Kanpur
37	15 CDV 6 steel sheets	HSL, Durgapur & Rourkela
38	Mandrel tefloning	Prasun, Calcutta
39	Heat treatment	HEC, Ranchi
40	Launcher	Richardson & Cruddas, Bombay
41	Heat treatment	HAL, Nasik
42 & 43	Motor cases, end domes	Anup, Ahmedabad
44	Heat treatment	Ordnance Factory, Muradnagar
45	Interstages	HAL, Kanpur
46	Guidance components, actuators	HAL, Lucknow

INSTITUTIONS: ADE - Hybrid simulation studies, DLRL - Antenna testing GTRE-Heat shield evaluation tests, IIT-Acoustic measurements and heat transfer studies, IISc - Launcher wind excitation studies and heat transfer measurements, NAL-Wind tunnel testing using models

operates on a back-up mode compensating for higher control force requirements that cannot be made up by the fin tip control system.

The launch also utilises a number of novel digital, electronic and computer devices. The pitch programme designed for the vehicle is stored in a vehicle attitude programmer using PROMs (programmable read-only memories) and operated through other digital devices. The SLV-3 flight system employs a triple redundant digital sequencer which uses three chains of sequencer with operations based on a majority voting system. This is implemented to ensure a high reliability of sequencing functions.

The electronic packages employed in SLV-3 make use of modern CMOS (complimentary metal oxide-semiconductors) and LSI (large scale integrated) devices which are at par with those designed and developed elsewhere. The SLV-3 check-out functions are performed through an automatic check-out computer. The schemes employed for this purpose compare with those adopted in advanced countries. The vehicle and check-out scheme for power systems, telemetry and control and guidance involves acquisition of a number of data and health parameters and stimuli response of the system at different times during the vehicle preparation for launch. The computerised check-out system was developed to perform these functions in a minimal time; inspecting the data to be obtained from a large number of systems even at T-10 minutes onwards

The solid propellant used in all the four stages belongs to high energy and advanced categories. In this vital field, India is self-reliant and self-sufficient with her own technology which compares with the best available in advanced nations. While the first and second stage motors employed a propellant based on a ter-polymer of polybutadiene, acrylic acid and acrylonitrile, the third and fourth stage propellants were based on the lactone-terminated polybutadiene, which is a new binder developed by VSSC scientists.

The launch and its objectives

The previous launch of 10 August, 1979 had been studied and the reason for failure had been found to be the malfunctioning of a valve in the reaction control system after the first stage separation. This time the launch was aimed primarily at realising SLV-3 launch vehicle system ready for the second experimental (E-02) flight, revalidating operational procedures, flight-testing the vehicle and fully evaluating the performance of the 44 major sub-systems.



Two telemetry stations (with back-up station) receive data from the vehicle and the Rohini technology payload during launch and orbital phases The figure shows a 24 dB SBF array antenna at SHAR TMII station

The launch also aimed at injecting the experimental RS-1 spacecraft payload into a low earth orbit and estimating the orbital elements using the tracking data and injection parameters obtained from the down range station. The launch was to establish the methodology of tracking and acquiring telemetry data from the payload in orbit and revalidate ground station and launch complex operations.

Over one lakh components used in the SLV-3 accounted for 44 major sub-systems, encompassing rocket motors, heat shield, separation systems, guidance package, vehicle electronics, apogee motor instrumentation, thermal protection system and destruction system. Apart from the various ISRO centres, 46 organisations including national laboratories, public sector undertakings, educational institutions and private industries participated in the development of SLV-3. The technologies relating to these subsystems were a mixed bag indeed; some were conservative, some contemporary and some innovative.

At least 43 of the 44 sub-systems have had to work within the specified close limits if the mission was to succeed. If any of these 43 sub-systems were to malfunction, the 44th subsystem (namely, the vehicle destruction system) had to be brought into play by telecommand. Of the 44 sub-systems, only the destruction system by remote control remained unproven. The actual orbit reached was nominal—300 km (perigee) and 900 km (apogee) The flight fulfilled all the objectives of the mission.

The launch of SLV-3 is undoubtedly a significant achievement, but it is a small step towards the goal of harnessing space technology for national development. The three major fields in which the country should achieve self-sufficiency are remote-sensing for resource survey, communications and meteorology. The satellites which can do this weigh no less than 500 kg. The next task before the VSSC is to build more powerful launch vehicles which will be capable of orbiting larger satellites ultimately in a synchronous orbit. Experience gained from SLV-3 has given us confidence that we will be able to build launch vehicles of 300 to 400-ton class, using both solid and liquid systems. We have probably all the rudiments to build such vehicles in this decade itself.



Dr Gowariker is the director of the Vikram Sarabhai Space Centre (VSSC), Trivandrum He obtained his M Sc and Ph D in Chemical Engineering from Birmingham University, UK. Before joining ISRO, he was with the UK Atomic Energy Authority and the Summerfield Research Station an agency establishment of the then British Ministry of Aviation as Senior Technical Officer

---

Blurs and Bright Spots
(Contd from p 12)

upon the common belief about eating during eclipse. We do not know what came out of these studies, but Dr. Badrinarayan of the Mental Hospital in Dharwar found that "disorderly behaviour among mental patients increased 24 hours before the eclipse".

The numerous reports on the effects of solar eclipse on animal behaviour are often contradictory and nearly always somewhat garbled and pointless, with pretentious emphasis on the electrical or biochemical equipment that was employed to make measurements. Rabbits are said to have developed rashes, guinea pigs gained white blood corpuscles and quails were blinded when the sun went into eclipse: According to "scientists" in Bhubaneshwar, "the little ants were the only living things that remained unaffected".

The botanists, too, made comparable observations on plants. Experiments at the Bose Institute in Calcutta "revealed a considerably higher rate of transpiration and pulsation" in *Gardenia floride* and *Desmodium gyrens*. These "surprising scientific data", according to the Indian Science News Association, "are expected to lead not only to an understanding of pulsation and ascent of sap but also to fundamental knowledge of plant physiology".

A group at the Calcutta University's Cytogenetics Department found that "the chromosomes of reproductive and somatic cells of some horticultural and leguminous plants behaved abnormally during the solar eclipse. These researchers feared that if the irregularities found in the reproductive cells persisted, the plants might produce non-viable seeds." Mercifully, the botanists at the Central Arid Zone Research Institute came to the conclusion that the eclipse has no significant effect on plant metabolism and biochemistry.

True, the sample of "solar-eclipse biology" that I have presented is biased and gives undue importance to newspaper versions of amateurish activity. The only printed material available to us consists of newspaper reports. Several important institutions and organisations were involved in studies on biological effects of the eclipse. The Bombay Natural History Society, for instance, sent a team to Bastar to observe the behaviour of animals during the eclipse. Several newspaper reports on the work of this team have appeared, but one does not yet know, scientifically speaking, what the team learnt. A few research papers on the effects of the eclipse have come to me from Indian scientific journals for refereeing. The level of science in these papers does not rise much above that of the newspaper accounts.

In his article "Superstition Around Eclipse", Darryl D' Monte (*Indian Express*, 16 February, 1980) quotes Vivek Monteiro as follows: "Most superstitions are based on fear and ignorance—all the more so in poor countries. Superstitions are based upon incorrect inferences from partial information. Superstition is only a small part of irrationality. Illogical beliefs arise out of psychological needs and therefore cannot be studied outside these needs. Giving accurate information is only a part of the fight against superstition. Superstition can only be eliminated when people begin to laugh at the irrational fears that gave rise to them."

Dr. Monteiro is very right, but the scientific superstitions described here are not those of poor people. No doubt these, too, arise from fears, insecurities and other psychological needs. One hopes scientists will learn to laugh at their fears. But the nagging question remains, how much of such "fearful science" must we have?

OBAID SIDDIQI

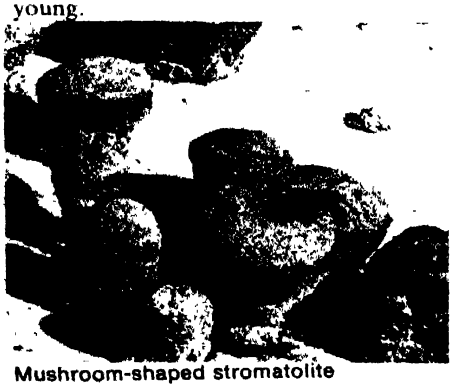
Prof. Siddiqi heads the Molecular Biology Group at the Tata Institute of Fundamental Research, Bombay.

Science Shapes Life

LIFE BEGAN WHEN THE EARTH WAS YOUNG

Current scientific belief holds that life is some 2.3 billion years old. Fossils to back this fact had come from southern Africa. Then another find from Greenland pushed back the frontier to 3.8 billion years ago. However, the finds supporting this date were challenged as being remnants of fluid inclusions or bubbles and not living cells. A recent find of bacterial fossils places the beginnings of life around 3.5 billion years ago—1.2 billion years older than the current belief.

The new find comes from an area called the North Pole in north-western Australia. This place is full of mushroom—like rocky structures which, scientists speculated, were built by living organisms down the ages (SCIENCE TODAY, January 1974, p 10.) No trace was found, of these organisms but scientists of the University of California, Los Angeles, have found filamentous fossils of chains of bacteria At least five different kinds of cells have been found. And for their age, these bacteria were quite complex. They even look like modern bacteria Professor J William Schopf, head of the research team, says that "the fossils demonstrate that the surface of the earth was habitable some three and a half billion years ago, and that it was populated by numerous types of relatively advanced bacterium-like forms of life". This means the primitive forms appeared much earlier. The earth is only four-and a half billion years old. Therefore, the first forms of life probably evolved when the earth was very young.



Mushroom-shaped stromatolite

HAZARDS OF VASECTOMY

Vasectomy, it is generally believed, is the safest and simplest form of contraception, with practically no side-effects. The only major drawback about the quick, easily performed operation is that the effect is not immediate and some other form of contraception has to be used for some time until the semen shows no sperms. Studies now show that the operation is not without its side-effects.

A recent research by Thomas Clarkson and Nancy Alexander, Bowman Gray School of Medicine, North Carolina, and the Oregon Regional Primate Research Center, both in USA, indicates that in the long run vasectomised monkeys tend to develop atherosclerosis of the major blood vessels. Whether the same is true for man is yet to be investigated.

Atherosclerosis is the thickening of blood vessels due to fatty deposits. These fatty deposits narrow the vessels and also provide focal points for the thrombus (blood clot) development which cause heart attacks and strokes.

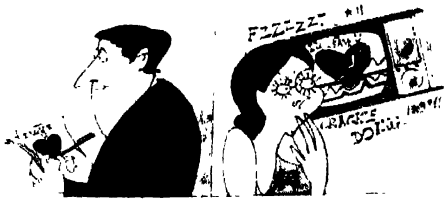
Clarkson and Alexander were studying the ways in which atherosclerosis is accelerated in monkeys by certain excessive or inappropriate immune reactions; vasectomy is known to cause immune reactions to person's own sperm cells. The American scientists studied seven normal and 10 vasectomised monkeys that had been fed on normal low-fat monkey diet The vasectomies had been carried out nine to 14 years before Biochemical tests showed that the treated monkeys had a marked deposition of fats in major blood vessels and also their blood contained more antibody protein than the normal animals In all other respects the treated monkeys were like the normal ones.

WRITE A PHONE CALL

With this new telephone you don't have to speak if you don't want to. Using a special ball point pen, the caller can write his message on an electronic writing pad, and the receiver gets the message on a television screen The new system called Scribofon has been developed by a Dutch concern; they call the technique scribophony.

The device consists of an electronic writing tablet, a TV screen, a coding device, a special pen and the normal telephone system. Under the paper of the writing pad is a double-sided printed circuit board which has 40 vertical tracks on one side and 40 horizontal tracks behind. The tracks are connected to registers such that when the pen containing an electrode and amplifier passes over it, a series of timed electronic impulses pass continuously through the printed circuit board. As the caller writes, the electrode in the pen makes contact with the tracks on the printed circuit board. The pulse stream changes with the position of the pen point. These signals are coded into digital form and transmitted through the telephone line.

On the receiving end the message passes through a decoder and comes out as a series of marker points that are displayed on a TV screen. An extrapolation circuitry fills in the spaces between the dots and the handwritten message is there. The size of the display can be increased at will.



This new system will be of help to the deaf and will also be of use in transmitting graphic messages. Since the information is sent in a digital form the receiver can alter the transmission as it arrives. One of the functions is a 'ruler' function that straightens out lines perfectly. Thus, a rough sketch emerges as an accurate one

SAFER RABIES VACCINE

Rabies vaccine, at present, is made either using sheep brain or duck embryos One of the main drawbacks of these vaccines is that they may cause unpleasant or violent reactions Considerable pain, itching and swelling are the common side-effects. Two new vaccines are now being tried out—one in France and the other in Switzerland.

Using fetal lung cells to grow the virus, scientists of the Institut Merieux, Lyon, France, have come up with a vaccine that can safely be used in people who are allergic to eggs. This is because the vaccine contains no embryonic duck-egg protein. The virus is inactivated before use. The vaccine is administered along with a blood plasma product which provides temporary protection It has been successfully tried out in Germany and Iran; none of the 76 people bitten by rabid animals and given the vaccine developed the disease The normal dose for this vaccine is five injections on the arm. It can also be given to people who are likely to be exposed to rabid animals—three before exposure and two more in case of a bite.

The second vaccine, still at the clinical testing stage, is a modified version of the duck-egg technique. Developed by Klaus R. Schell and his team at the Swiss Serum and Vaccine Institute in Berne, this vaccine has been tried out on volunteers. This highly purified concentrated vaccine provoked fewer allergic reactions because of its low egg protein content. It could then probably be used in shorter series.

HOW DID LIFE BEGIN?

In the beginning, biologists tell us, the earth was shrouded in an atmosphere of water vapour and reducing gases such as hydrogen, methane and ammonia Electric discharges through this atmosphere, it is believed, gave rise to the building blocks of life and subsequently the atmosphere got oxidised

There is one major discrepancy in this theory Our two closely related planets, Venus and Mars, both have an oxidised climate and none of them has any form of life, how then did their atmospheres get oxidised? Probably, the oxidised atmosphere was the primitive form, say Ann Henderson Sellers of Liverpool University and A Benlow and Jack Meadows of Leicester University in UK They came to this conclusion after studying how atmospheric composition affects the planet's surface temperature By assuming that the earth, like its rocky neighbours, had an oxidised primeval atmosphere of gases like nitrogen, carbon dioxide and water vapour, the predicted values of surface temperature were found to match the geological record Such a mixture could also yield the building blocks of life when electric charges and ultraviolet radiations pass through them, according to recent experiments Also, the volcanic emissions which bring out gases from the earth's interior are almost of the same constitution as the supposed primeval atmosphere of the oxidised atmosphere models The surface temperature of a rocky planet depends not only on its distance from the sun but also on the greenhouse effect of its atmosphere Using these astrophysical models for the three planets, the scientists have found the figures of the calculated surface temperatures match the actual values

TAMPONS CAN BE FATAL

Toxic-shock syndrome, a mystery disease which mostly strikes women under 30, can sometimes be fatal High fever, vomiting and diarroea followed by prolonged shock and low blood pressure are the symptoms of the disease What caused the disease remained a mystery The disease, first decribed two years ago, was attributed to bacteria *Staphylococcus aureus*

Katharyn Shands, an epidemiologist at the Center for Disease Control, Atlanta, USA meanwhile stumbled on a clue Nearly all the victims of the disease she found, used tampons In healthy women of the same age, only 86 per cent used tampons The tampon acts as a growth encouraging medium or helps bacteria in some way to release the toxin or perhaps helps toxin absorption into the blood

THE EARTH IS FLIPPING

Once in every 500,000 to one million years the earth turns upside down, its magnetic poles change polarity. This is said to be accompanied by mass extinctions of certain life forms, since during the reversal when field strength approaches zero there is an influx of death-dealing ultraviolet radiations and cosmic rays which are usually held at bay by the magnetic field



The last geomagnetic field reversal occurred some 700,000 years ago Is the next one round the corner? Perhaps it is Results from the Magnetic Field Satellite (Magsat) which measured the earth's main magnetic field as well as the fine anomalies in the crust confirmed that the intensity of the earth's magnetic field has been decreasing over the years Previous studies had also pointed to the same fact The rate of decrease is estimated to be 26 nanoteslas (nT) per year (nT is a unit of magnetic flux density) At this rate, within 1200 years the field strength should become zero, after which the field would regenerate, but then the polarity would change But are we really witnessing a reversing field? Scientists are not quite sure whether these fluctuations will lead to a reversal or whether they are normal events

REFUSE AS ENERGY RAW MATERIAL

Waste disposal will soon be a problem for the Germans They will have no place to throw it About 1,000 delegates to the International Re-cycling Congress held in West Berlin stressed the importance of thinking seriously about the waste disposal problem The potential energy content of the annual deluge of rubbish from German households and industry would suffice to cover about two per cent of the annual energy needs of the Federal Republic of Germany, they concluded

Already, domestic refuse is being incinerated to produce thermal energy But this is a very expensive process and has the disadvantage that the energy thus produced must be used immediately. Since computer calculations say that, by the year 1990, there will be no place to dispose of the refuse produced by nine million Germans, the Federal Government sponsored a research programme known as "New processes for the thermal treatment of refuse"

The most promising solution so far is the "pyrolysis process" in which rubbish is not incinerated but either degasified or turned into gas In gasification, only some of the refuse is used to degasify the remaining refuse under airtight conditions This more or less simulates the natural processes which have created the coal seams This 'cokes' the refuse into its various components such as oil, gas, soot and refuse coke The first large-scale pyrolysis plant is now being built in Bavaria and it will process some 35,000 tonnes of refuse a year in its refuse reactor and yield an estimated 3 6 million kilowatt hours of energy—chiefly gas A pyrolysis reactor of this type will probably be not only less expensive, less pollutive and more productive, but will also make it possible to get the very best out of the wastes, industrial waste such as used oil, paint and dye residues, synthetics and largely poisonous waste from purification plants could then be disposed of easily along with domestic refuse

The re-cycling process would not only offer the prospect of regaining energy in the form of gas but also recover raw materials of value to industry However, there is one unanswered question worrying the experts in order to separate the materials gained through pyrolysis, they have to be subjected to intensive rinsing And this produces enriched waste water containing many contaminants—waste-waste, so to speak—which is almost even more difficult to dispose of But the experts are already grappling with this poser, too

BUGS TOO CAN BE PATENTED NOW

PATENTING living organisms is tricky A General Electric Company scientist, Dr Ananda M Chakrabarty, created a new supermicrobe to tackle oilspills Generally, several strains of bacteria are involved in the degradation of different petroleum fractions The new bug cre-



ated by Chakrabarty, with its multiple plasmids, could digest two-thirds of the hydrocarbons in oil at a much faster rate and more efficiently than any known bacterial strain. Chakrabarty put in the oil-digesting ability of four *Pseudomonas* into one (SCIENCE TODAY November 1975, p. 12).

There were problems of obtaining a patent on this miracle bug because the US patent law does not include living organisms explicitly. The supporters of the patent applications (which had been rejected by the patent office) and their opponents were equally loud in their arguments. Supporters put forth the immense economic gains while opponents expressed their fears about the hazards.

In 1930, the US Congress had passed a special law allowing patents on a sexually reproduced plants. This law extended to new plant varieties in 1970. The very fact that such laws were made, the US Patent Office argued, was to exclude living matter. However, the patent legislation's original author, Thomas Jefferson's argument that "ingenuity should receive a liberal encouragement" won the case for the patent application supporters in the US Supreme Court—a ruling which will boost scientific research.

WORK: NECESSITY OR ADDICTION?

In a survey carried out by the Emnid Institute of Bielefeld, Federal Republic of Germany, questions were put to 517 typical Germans to find out what they thought of their jobs.

Four out of 10 people answered that they went out to work only to earn money. Of the total, 28 per cent regarded their work as a "satisfying activity", 12 per cent as "fulfilling a task", 18 per cent as a "necessary evil" and one per cent as a "major burden". Those with higher education levels are happiest at their work, they found. The better their education, the more stimulated they usually are by the jobs they do. The survey also revealed that self-employed people and farmers are much more in harmony with their employment than white-collar workers and civil servants. Some 38 per cent of the self-employed said they were highly satisfied with their work. An interesting fact is that women are usually more pleased with their jobs than men. Only 13 per cent of the women against 21 per cent of the men, questioned regarded their employment as a "necessary evil". Perhaps this is because the female isn't often dependent on a job.

But work can also become an addiction, almost like nicotine, alcohol or drugs. The causes of "work addiction" were examined by psychoanalyst and head doctor Dr. Gerhard Menzel. He discovered that certain behavioural characteristics of alcoholics and "work addicts" were conspicuously similar. For example, their thoughts are permanently preoccupied with the "drug"—work or alcohol.

Initially, they neglect their families, admit to no feelings of guilt and gloss over symptoms of fatigue. The main stages are marked by increasing loss of self-control, an irresistible urge to go on working or the tendency to keep a permanent stock of work available.

This lust for work can't be cured when the causes have been analysed can therapy begin and the patient be liberated from his work addiction.

GARMENT - GRADING MANNEQUIN

Sam is a black anodised copper mannequin at Kansas State University, USA. Under his copper exterior are heating wires in a cloth carrier that are used to maintain him at a constant skin temperature of 92° F (about 33° C). And this is monitored by thermistors. By measuring the amount of power used to maintain the temperature at 33° C and by taking into account the air layer around Sam, the insulation value of various clothes can be calculated.



The insulation value indicates the thermal comfort of clothes.

There are a few other such mannequins but only two others are for civilian use—one is in Denmark and the other West Germany.

Elizabeth McCollough of the Kansas State University calculated the necessary amount of clothing for comfort. She found that the western male executive in his formal office wear is generally overdressed in summer. The women, on the other hand, are not adequately dressed to keep warm in winters. If such mannequins were easily available, it would help manufacturers to include thermal comfort values (measured in units called 'clo') on the garment.

COULD A CHIP TRIGGER WORLD WAR 3?

Early in June this year, a North American Air Defense Command's (NORAD) surveillance computer, buried 500 metres deep inside the Cheyenne mountain in Colorado, USA, raised an alarm, "the Russians are coming". Almost immediately 150 B-52 bomber crews swung into action, revved the engines and awaited commands for take-off. Hurried crosschecks from radar and satellite sensors, however, failed to corroborate the computer's alarm and so the take-off command was not given. This was on 3 June 1980. Two days later, the same thing happened again. And it is believed a similar incident had taken place in November last year.

The 6 June incident was claimed to be intentional, the 3 June false alarm was blamed on a chip in NORAD's communications multiplexer. The multiplexer makes the information from NORAD's computer suitable for transmission, such that the receiving stations can easily identify and interpret the message. The Wimex (Worldwide Military Command and Control System) controls all the command posts in charge of the defence affairs. The Wimex is based on the attached 1964 Honeywell computer. It is unreliable and has actually broken down during a recent crisis—the Jonestown incident where a US Congressman and three reporters lost their lives. According to John H. Bradely, a former senior test engineer, the computer was breaking down once every 35 minutes on an average. "I am certain it is still happening all the time. It is a miracle that nothing terrible has happened as a result," says Bradely. The chip that caused the false warnings costs about Rs. 3.50 (46 US cents).

One dreads to think of what would have happened if the Russians had mistaken the American defence alert in response to the alarm as a preparation for war and retaliated





MELTRON MAGNETIC Cassettes and Tapes— the latest sound sensation!

Meltron introduces sound value for connoisseurs of music High quality audio magnetic cassettes and tapes.

Special graphite-coated tapes with a wide frequency response.



Track down the tapes of your choice.
They'll strike the right notes for you.
Again...and again...

MELTRON Meeting the challenge of tomorrow.

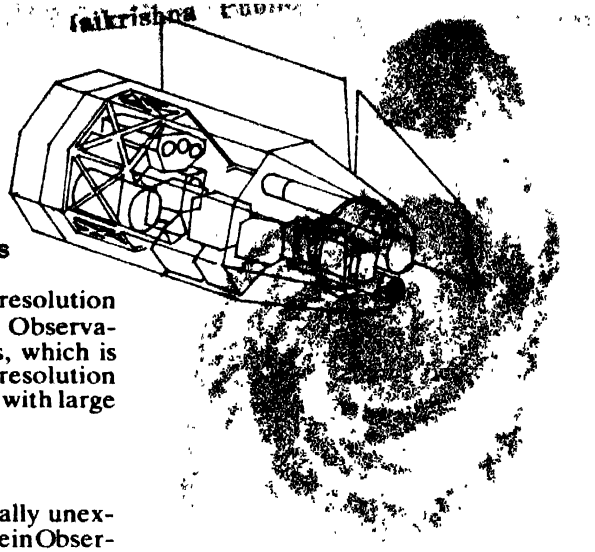
Marketed by: Maharashtra Electronics Corporation Limited
Plot No. 214, Backbay Reclamation, Raheja Centre, 13th Floor, Nariman Point, Bombay 400 021.
Tel: 240538 Telex: 011-6817 ME Cable: MELTRON
7A, Hansalaya, 15, Barakhamba Road, New Delhi 110 001. Tel: 40641 Telex: 031-2815 MELN
55, Rama Nivas, 10th Cross, West of Chord Road, II Stage, Bangalore 560 010. Tel: 80772.

CHAITRA-ME-86

Seeing the universe through X-rays

P. C. Agrawal

New insights into the mysteries of stars, galaxies and quasars



THE launch of the Einstein X-ray Observatory in November 1978 heralded the beginning of a new era in the rapidly evolving field of X-ray astronomy. Observations carried out over the past one-and-a-half years with the Einstein Observatory have made a profound impact on many areas of galactic and extra galactic astronomies. Even the first results of these observations have shaken some well-proven theories like those of formation of stellar coronae, the origin of diffuse cosmic X-ray background and the nature of X-ray sources in the globular clusters.

The EinsteinObservatory has a sensitivity vastly superior—(1,000 times higher) to that of the first X-ray observatory Uhuru, which has enabled it to probe the mysteries of even the farthermost objects located close to the observable edge of our universe. (SCIENCE TODAY, June 1979, p. 27). The sensitivity of the EinsteinObservatory in the X-ray region matches that of the 5m Palomar telescope (USA) in the visible band and that of the Westerbork telescope in the radio region, both of which are the most sensitive instruments of their kind in their respective wavelength bands. This is amply demonstrated by the recent detection of X-ray emission from the quasar OQ172. This quasar has a redshift of 3.53, which implies a distance of 15 billion light years; it is thus the most distant known object in the universe.

What has made this enormous advance in the sensitivity of the EinsteinObservatory possible is the use of an ingenious instrument known as the "grazing reflection X-ray telescope", originally proposed by Riccardo Giacconi and Bruno Rossi in the USA for use in X-ray astronomy. In this technique, X-ray photons incident at very shallow angles (less than a degree or so) are reflected successively from paraboloid and hyperboloid-shaped mirror surfaces and brought to a focus to form 'X-ray images' of the celestial sources of X-rays much in the same way as optical telescopes form visible images. The X-ray images are then detected and analysed by a variety of X-ray detectors located in the focal plane, to derive information about the position, size, structure and spectral distribution of the X-ray emitting objects. The best angular resolution attained with the Einstein Observatory is about 2 arc seconds, which is comparable to the angular resolution achieved in the visible band with large size optical telescopes.

Unexpected findings

One of the major and totally unexpected findings of the EinsteinObservatory has been that stars of all spectral types emit X-rays. Stars are classified, on the basis of their spectral characteristics which, in turn, depend on their photospheric temperatures, into several classes designated by the letters O, B, A, F, G, K, M, R, N and S ("Oh, Be A Fine Girl, Kiss Me Right Now, Smack" is a useful mnemonic to memorise the spectral sequence). The stars of spectral classes O, B and A are called early type stars and the others are called late type stars. The photospheric temperatures of these stars range from about 50,000°K for the hottest O stars to about 3000°K for M stars. The sun is an ordinary star of spectral type G2 and has a temperature of 5800°K.

Before the launch of the Einstein, X-rays had been detected from only a small number of late type stars. Some of these were members of a class of binary systems known as RS Canum Venaticorum binaries (RS CVn). The star system Capella, a bright X-ray emitter in the constellation Auriga, located 45 light years away, belongs to the RS CVn group. A few X-ray emitting stars belonged to a class of stars known as Cataclysmic Variables, which undergo regular optical eruptions; SS Cygni and U Gem belong to this class. The remaining X-ray emitting stars were either white dwarfs or flare stars which exhibit sporadic optical and radio flaring.

The Einstein observations have now conclusively established that both the early type as well as the late type stars are prolific X-ray emitters. In general, the early type stars are brighter X-ray sources than the late type stars; the X-ray luminosity of some of the O stars is almost a million times higher than that of the sun. (The X-ray luminosity of the sun is only about a millionth of its optical luminosity.) The X-ray luminosity decreases as one goes from hotter stars to cooler stars. However, the typical value of X-ray luminosity for K and M stars are a factor of 10 to 1000 times higher than that of the sun.The energy output of most of these stars in the form of X-rays is only one part in a million to one part in 10,00 of their total energy output. In the case of some of the M stars, however, as much as one-tenth of the total energy is emitted as X-rays.

Among the well-known stars detected as X-ray emitters are Alpha Centauri, our nearest stellar neighbour and Sirius, the brightest star in the northern sky. Both these stars are binary systems and X-ray emission has been detected from both the components of these binaries. During the Einstein observations, a bright X-ray flare, similar to flares occurring on the sun, was recorded from another nearby star, Proxima Centauri, located 4.3 light years away. X-ray emission has been discovered from single stars as well as from stars in clusters and associations. One of the well-known star clusters is Hyades, which is 136 light years away, and includes several hundred stars whose age is estimated to be about a billion years. A systematic survey of this cluster has so far revealed the presence of about 25 X-ray emitters. A typical Einstein field recorded in the Hyades cluster is shown on p. 25 which shows an X-ray image of a source identified with the star Tau 71. A large number of X-ray emitting O, B stars have been found in the OB associations (associations of early type stars), in the Orion Nebula and near the Eta Carina Nebula.

Stellar coronae

The most plausible explanation for X-ray emission from these stars is in terms of the 'Corona model' in which the X-rays are generated as thermal emission from an envelope of hot gas surrounding the star. From

analysis of the X-ray spectra of the stars, temperatures of the hot plasma have been derived to be in the range of two million to twenty million degrees. At such high temperatures, most of the atoms of various elements present in the coronae are in a highly ionised state. If X-ray emission is indeed of thermal origin, then due to collisional excitation and radiative recombination effects, X-rays emission lines of the most abundant ions present in the coronae should be detectable. A good example of a coronal X-ray source is the solar corona, which is at a temperature of two million degrees and emits X-rays at a rate of about one-millionth the total energy radiated by the sun. High spectral resolution observations of the sun from a number of satellite-borne instruments have revealed the presence of a very large number of X-ray emission lines due to various ions and thus enabled determination of the abundances of various elements present in the solar corona. Similar observations of a number of stars, many in RS CVn binaries, with the solid state spectrometer on the Einstein, have for the first time unambiguously shown the presence of X-ray emission lines in the spectra of these stars, confirming the general validity of the coronal emission model. Figure 1 shows the energy spectrum of the star Sigma Corona Borealis, observed with the Einstein. Presence of X-ray emission lines due to Magnesium XI ions (that is, magnesium atoms which have lost ten electrons each) at about 1.3 KeV and due to Silicon XIII ions at about 1.8 KeV are clearly discernible in the spectrum. A broad emission feature between 0.8 and 1 KeV is due to a blend of the various unresolved emission lines of Iron XVII and XVIII ions. From the intensity of these emission lines, it has been concluded that in Sigma Corona Borealis the abundances of elements like iron, magnesium, silicon, etc are identical with those observed in the sun. The Einstein has thus provided us for the first time a capability to measure elemental abundances in the coronae of stars and compare these with the elemental abundances in the photospheres of these stars deduced from the optical spectra.

The discovery of coronae around the hot O, B stars as well as in the very late K, M stars is in conflict with the predictions of the conventional theory of formation of stellar coronae. According to this theory, presence of a deep hydrogen connective zone is the prime requirement for the formation of corona around a star. The convection process transports energy from the deep interior of a star to its surface and the turbulence

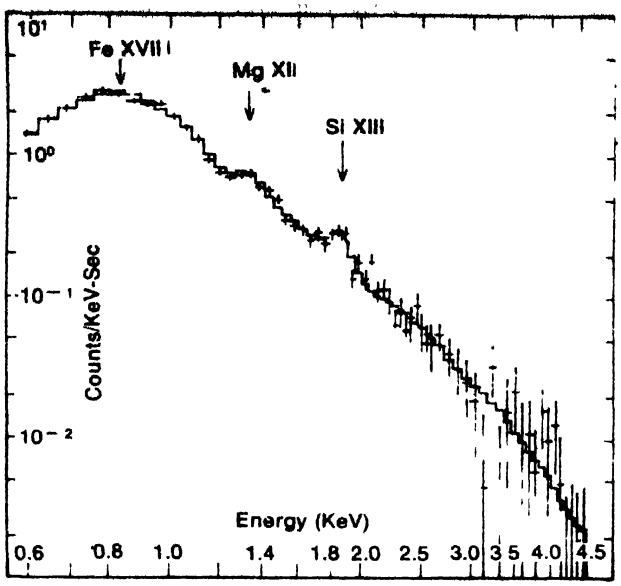


Fig.1. X-ray spectrum of the binary star Sigma Corona Borealis obtained with the solid state spectrometer on the Einstein Observatory. This spectroscopic binary of 1.1 day period is 75 light years away. The spectrum reveals the presence of X-ray emission lines due to highly ionised atoms of magnesium, silicon and iron. The presence of such highly ionised atoms implies temperatures of several million degrees for the X-ray emitting plasma. From the intensities of the lines it has been estimated that abundances of elements like iron, magnesium, silicon, etc in this binary system are similar to those observed in the sun. This spectrum was obtained by the author and Dr. Riegler

associated with the convection leads to the generation of acoustic waves. The mechanical energy dissipated by these acoustic waves leads to the formation and maintenance of the chromosphere and corona around a star. Since the O and B stars do not have convection zones, they should not have coronae in this picture. According to the theory, only F, G and late A type stars have all the appropriate conditions for the formation of coronae at certain times in their evolutionary stage. This is in sharp disagreement with the Einstein observations and indicates serious flaws in the current theory of stellar coronae. Considerable theoretical efforts are in progress to devise new models of heating and forming coronae. It appears that the presence of chaotic magnetic fields and rapid rotation of the stars play crucial roles in making stellar coronae.

Supernova remnants

Another group of galactic sources on which the EinsteinObservatory has provided truly remarkable results are the supernovae remnants in our galaxy and in the Large Magellanic Cloud (LMC) which is an irregular-shaped satellite galaxy located at a distance of 170,000 light years away. A supernova remnant is the debris of a massive star which has exploded after exhausting its nuclear fuel at the end of its evolution. According to the present understanding, the star core collapses at the time of supernova explosion to form either a neutron star or a black hole depending on the mass of the core. A shock accompanying the stellar collapse ejects the outer layers of the star into the interstellar medium with a very high velocity. The ejected material, in the form of a shell, propagates radially into the interstellar space at supersonic velocities. The interaction of this expanding shell with the interstellar medium leads to the generation of a blast wave which travels slightly faster than the ejected shell. As the blast wave propagates into the interstellar material, it sweeps up the surrounding material and the material immediately behind the shock front is compressed and heated to a temperature between one million and a hundred million degrees. This heated gas radiates energy in the X-ray spectral band. This model, known as "Supernova Shock Wave Model", was first proposed by the Russian astrophysicist Shklovsky in 1962.

The detection of X-ray emission from several young and old supernovae remnants in the early seventies from rocket flight experiments established them as a distinct class of X-ray sources. Of about 120 catalogued supernovae remnants in our galaxy, about 15 had been discovered as X-ray emitters before the Einstein mission. These include three of the youngest supernovae remnants in the galaxy, namely, Tycho's supernova event observed by the Danish astronomer Tycho Brahe in 1572, Kepler's supernova event recorded by the famous astronomer Johannes Kepler in 1604, and Cassiopeia A (Cas A) which occurred around 1667 but was not detected on the Earth. The Einstein has recorded beautiful X-ray images of these three objects. An almost perfect circular shell-like structure is seen in the X-ray images of both the Tycho and Kepler's supernova remnants, remarkably confirming the validity of the supernova shock wave model. The X-ray image of Tycho's supernova shows a striking similarity to its radio image. Figure 2 shows the Einstein X-ray image of the Cas A supernova remnant which also reveals a roughly circular shell that probably indicates



Harvard-Smithsonian Center for Astrophysics

Fig.2: High resolution X-ray image of Cassiopeia A (Cas A), remnant of a supernova explosion that occurred around 1667. Cas A is the brightest radio source in the sky and is also a powerful X-ray emitter. The image reveals a roughly circular shell of 2 arc minute radius. Bright X-ray spots seen in the image correspond to the knots and filaments seen in the optical image of Cas A. No point-like source, indicative of the presence of a neutron star, near the centre of Cas A has been observed

the shock front boundary. Several bright X-ray spots inside the shell correspond to fast-moving 'knots' and filaments seen in the optical image of the supernova. Strong emission lines from transitions of helium-like ions of silicon (1.86 KeV), sulphur (2.46 KeV) and argon (3.1 KeV) stand out in the spectrum of Cas A, confirming that X-rays are indeed generated in a shock-heated hot plasma. This provides additional support for the correctness of the shock wave theory. The intensity of these emission lines leads to the conclusion that heavy elements are two to three times as abundant in Cas A as they are in the sun. The energy spectrum of Tycho's supernova shown in Figure 3 reveals even more intense emission lines of silicon, sulphur, argon and calcium and suggests that these elements are overabundant by a factor of at least six compared to the solar values. Enrichment of heavy elements in these supernovae remnants strengthens the idea that heavy elements are synthesised in supernovae explosions.

A systematic survey of the LMC carried out by the Einstein has led to the discovery of X-ray emission from about 20 supernovae remnants in that galaxy. Supernovae remnants in the LMC seem to be identical to those in our galaxy except in two important respects. First, their intrinsic X-ray luminosity is an order of magnitude higher than that of the galactic supernovae remnants. Second, the temperature of the X-ray emitting hot gas seems to be lower for the LMC supernovae remnants.

Detection of hot neutron stars

Neutron stars, extremely compact objects composed of degenerate nuclear matter, are thought to be born in supernovae explosions. The discovery of pulsars, which are rapidly rotating neutron stars, in two of the well-known supernova remnants, Crab

Goddard Space Flight Center

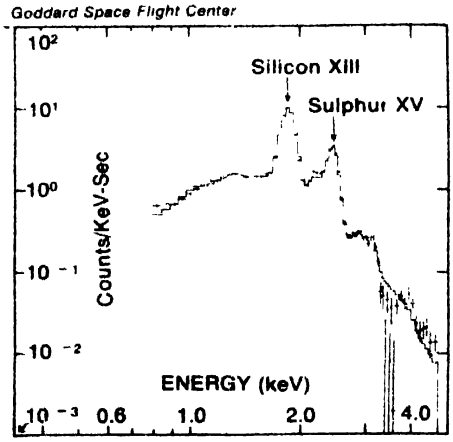


Fig.3. X-ray spectrum of Tycho's Supernova Remnant. The event was recorded by the astronomer Tycho Brahe in 1572. The spectrum was measured with the solid state spectrometer. Intense X-ray emission lines due to silicon XIII ions at 1.86 KeV and sulphur XV ions at 2.45 KeV are prominently seen in the spectrum. Analysis of the spectrum shows that elements like silicon, sulphur and argon are at least six times more abundant in Tycho's supernova remnant than they are in the sun

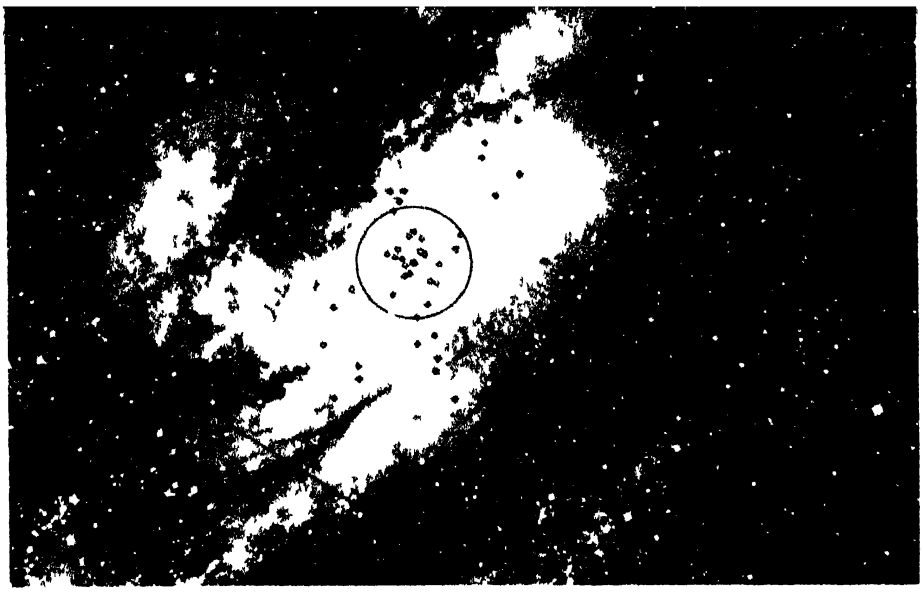
Nebula and Vela X, provides strong support for this idea. At the time of their birth, they are supposed to be very hot; a one-day old neutron star is thought to have a temperature of about a billion degrees. However, initially they cool rapidly by losing energy through neutrino emission. In the standard neutrino-cooling dominated model, the temperature of a 350-year-old neutron star is estimated to be 3.5 to 15 million degrees, which decreases to two to five million degrees after 10,000 years. A star with such a high surface temperature should be a copious thermal X-ray emitter, and is within the detection capability of the Einstein. A careful search of the three youngest supernovae remnants in the galaxy, Cas A, Kepler and Tycho, conducted with the Einstein has failed to locate any point source of X-rays within these remnants, and an upper limit of about two million degrees has been placed on the temperature of any such source. A point-like soft X-ray source has, however, been discovered by the Einstein near the centre of another supernova remnant, RCW 103, which is thought to be less than a thousand years old. If association of the point-source with the supernova RCW 103 is real, then the X-ray source is most probably the stellar remnant of the supernova explosion, that is, a neutron star. This will make RCW 103 the first supernova remnant in which a hot neutron star has actually been detected. Assuming the X-ray source to be a neutron star, its temperature is estimated to be 2.5 million degrees, which is not far from the theoretically expected value for a thousand-year-old neutron star.

The absence of any hot stellar remnant in the three youngest supernovae remnants suggests that either the temperature of neutron stars is too low to radiate X-rays or that neutron stars are not always formed in supernovae explosions. The first explanation implies that the cooling rate of neutron stars is faster than the computed theoretical rate. This points to the need for revising the neutron star models. The second explanation means that either black holes are formed more frequently than neutron stars in supernovae explosions or it is possible that the stellar cores are completely disrupted in the explosions of massive stars, leaving nothing behind. These explanations will, however, create more difficulties in explaining the estimated pulsar birth rate of one per five year which is already difficult to reconcile with the galactic supernova rate of about one per 40 years. This points to the need for devising new methods for the formation of neutron stars.

Extra-galactic X-ray sources

The Einstein has also brought about a revolutionary change in the study of extragalactic X-ray sources Its vastly better resolving power and sensitivity have made it possible for the first time to resolve and investigate individual X-ray emitting objects in nearby galaxies and individual galaxies in the clusters of galaxies As a result, one is able to see the same kind of fine details in the X-ray images of galaxies as one sees in their optical and radio images A fine illustration of the Einstein's capability is provided by the results obtained on the nearest spiral galaxy known as Andromeda Nebula (also known as M31) which is 2 3 million light years away This galaxy resembles our own galaxy in many respects and was detected as a very faint X ray source by the *Uhuru* satellite Because of rather poor resolution and limited sensitivity, *Uhuru* could not resolve individual sources in this galaxy A systematic mapping of the Andromeda Nebula, which has an angular size of about 100 arc minutes carried out by the Einstein Observatory has so far led to the detection of 88 X-ray sources in this galaxy X-ray luminosity of these sources is comparable to that of the bright sources in our galaxy One of these sources has been found to be pulsating with a period of 8 35 seconds

The nature of X-ray sources in M31 is not very different from that observed in our galaxy Three categories of X-ray sources, those located in the central bulge of the galaxy, those found in the spiral arms, and sources identified with the globular clusters around the galactic disc, have all been found in M31 Figure 4 shows an optical image of the central region of M31 and position of the X-ray sources detected in the inner region are marked over the optical image The most interesting of these new sources is a bright object of luminosity 10^{38} ergs per second which appears to be coincident within two arc seconds of the nucleus of M31 This is in sharp contrast to the nucleus of our galaxy which is a rather weak X-ray emitter its X-ray luminosity being at least a factor of 1000 lower than that of the nucleus of M31 It has been suggested that a massive object with a mass of about five million solar masses, may be present near the centre of our galaxy The presence of such massive objects has also been inferred in the nuclei of a class of galaxies known as Seyfert galaxies, which have very bright active nuclei and are amongst the most luminous X-ray sources It is, therefore, conceivable that the nucleus of M31 may also contain a massive object X-ray emission can then be explained as thermal emission from gas accreting on to the massive object and which is heated during its fall into the gravitational field of the object



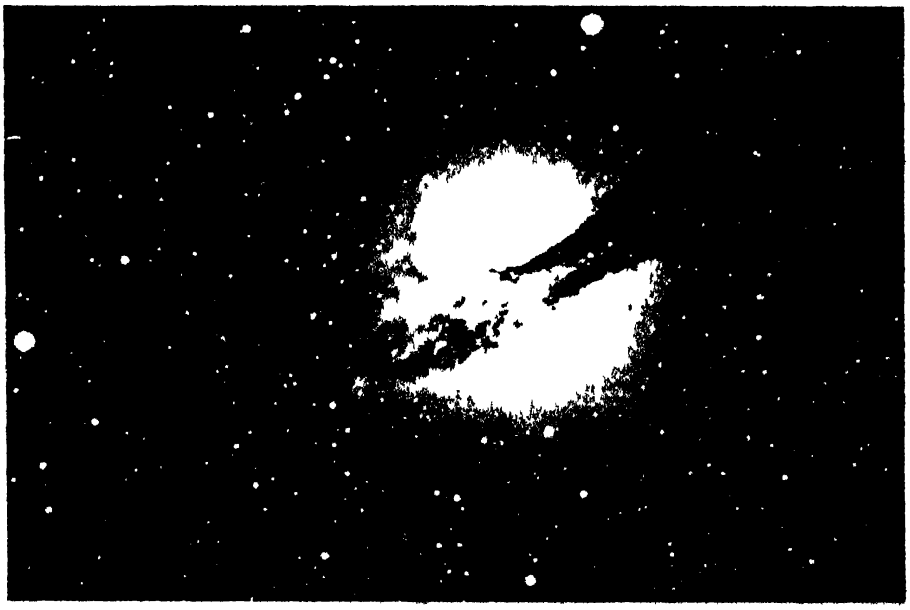
University of Chicago Press

Fig 4 Optical image of the central region of the nearest spiral galaxy M31 (also known as Andromeda Nebula) located 2 3 million light years away Positions of the X ray sources detected by the Einstein Observatory are indicated Sources shown in the circle are located in the inner bulge of the galaxy A bright X ray source is located within two arc -seconds of the nucleus and is thought to be coincident with it The Einstein Observatory has so far detected 88 X ray sources in M31

X-ray jet in Cen A

The radio source Centaurus A (Cen A), which is coincident with the giant elliptical galaxy NGC 5128 (Fig 5) is one of the objects whose structure at the X-ray wavelength has recently been studied This is the nearest radio galaxy (about 16 million light years distant) and is amongst the most powerful radio emitters in the sky Its structure in the optical and radio bands has been well determined The radio image of Cen A shows a complex double-lobe structure with a bright compact source at its nucleus The optical image shows a thick dust lane across the centre of the galaxy as

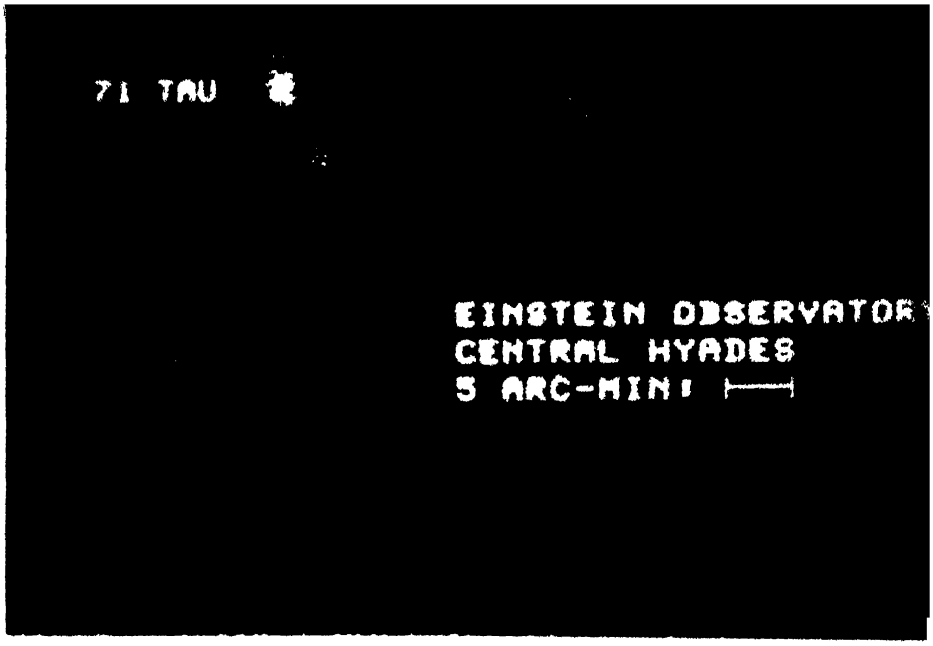
Fig 5 Photograph of the giant elliptical galaxy NGC 5128 which is coincident with the bright radio source Centaurus A Dark strips seen in the photograph are dust lanes across the centre of the galaxy The nucleus of NGC 5128 is a powerful radio infrared and X ray source The energy output of this galaxy in the X ray band alone is equivalent to the luminosity of about a billion suns An X ray jet emerging from the nucleus and coaligned with the optical jet has been also discovered which suggests that material is being continuously ejected from the nucleus of NGC 5128



seen in Figure 5. High resolution photography of Cen A in 1975 revealed the presence of gas and young blue stars in it. This is quite unlike other normal elliptical galaxies which are usually deficient in gas and dust and mainly contain old stars. An optical jet emanating from the centre of the galaxy and extending out to a distance of 130,000 light years, was also discovered. The nucleus of Cen A is also known to be a powerful infrared and X-ray source. The X-ray image obtained by the Einstein confirms the presence of a compact X-ray source at the nucleus of Cen A which is pouring out energy in X-ray at a rate of 10 billion times the solar luminosity. It is, however, found that this source is immersed in an extended X-ray emitting envelope of about 20,000 light years in size. The intense X-ray emission from the nucleus can be explained in terms of synchrotron self-Compton mechanism. In this process synchrotron photons, which are produced by high energy electrons spiralling in the magnetic field of the source, undergo Compton-scattering with the parent electrons and emerge as energetic X-ray photons. The origin of the extended component is, however, not well understood. The X-ray image of Cen A also reveals diffuse X-ray emission from the inner radio lobes. From the observed energy distribution of X-rays, it is inferred that this component arises due to inverse Compton-scattering of radio-emitting electrons with the 3^{0}K microwave background photons. However, the most remarkable result from X-ray imaging observations is the discovery of an X-ray jet which is well aligned with the optical jet and lies within it. The X-ray jet is located between the nucleus and the inner radio lobe of Cen A. The presence of the X-ray jet and its alignment with the optical jet strongly suggest that material in the form of hot plasma is being continuously ejected from the nucleus of Cen A. The ejected hot plasma jet initially radiates in the X-ray band but its emission gradually shifts to the visible band as it cools down during its outward motion. The jet also provides the necessary continuous energy input for the inner radio lobes

Seyferts: the brightest galaxies

Of all the galaxies, Type I Seyfert galaxies are the most prolific and powerful X-ray emitters. A Type I Seyfert is characterised by a bright, star-like nucleus which gives intense broad emission lines. The widths of the lines imply mass motion in the nuclei of these objects with velocities of several thousand km/second. They are generally weak radio-emitters, but are very bright infrared sources.



X-ray image of a small region in the Hyades star cluster which is 136 light-years away, obtained with the imaging proportional counter on the Einstein Observatory The star-like X-ray image seen in the picture is due to Tau 71 a main sequence star of spectral class FO. Scattered dots seen all over the picture are due to background radiation

In 1971, X-ray emission was discovered from one of the nearest Seyfert galaxy NGC 4151, which is now known to be a powerful source of X-rays of up to at least 100 keV energy. Subsequent studies with many satellite missions have led to the detection of X-rays from an increasing number of Seyferts. Of the 120 or so known Type I Seyfert galaxies, about 30 were known to be X-ray emitters by the end of 1978 A recent Einstein survey of 23 Type I Seyferts has revealed X-ray emission from 17 more of these objects. The energy output of these galaxies is truly enormous, ten to hundred thousand times that of our galaxy in the X-ray band alone Some of the Seyferts also show rapid variability on a time scale of days In the case of NGC 4151, an X-ray flare event which lasted less than an hour was also recorded. These X-ray intensity variations suggest that the size of the X-ray emitting region is very small, being only about 10^{15} cm. What is the source that produces such high amount of energy in a volume of size a few times the diameter of the solar system? Answer to this question is still far from clear. Many astrophysicists have conjectured that a massive black hole of one to ten million solar masses present in the nuclei of Seyferts may be the source. The release of gravitational energy by accretion of gas into this black hole will give rise to the observed radiation.

Clusters of galaxies

Amongst extragalactic X-ray sources, clusters of galaxies occupy a very prominent position on account of their high X-ray luminosities, typically in the 10^{43} to 10^{45} ergs per second range These clusters are a result of a peculiar but yet unexplained tendency of galaxies to group together. It has been estimated that about a half of all the galaxies in the universe lie in the clusters. The number of galaxies in a cluster range from several tens to a thousand or more, depending on the richness of the cluster. About 2,700 clusters of galaxies have been optically detected and catalogued by the American astronomer George Abell after whom these are referred to as 'Abell Clusters'. The Virgo cluster, containing about 2,500 galaxies and occupying a region of approximately 100 square degrees in the sky, is the nearest rich cluster located at about 62 million light-years distance. Some of the rich clusters have a very bright dominant galaxy at their centre. A supergiant elliptical galaxy, M87, with a beautiful jet protruding from its nucleus, lies near the centre of the Virgo cluster while another elliptical galaxy, NGC 1275, is located at the centre of the Perseus cluster. Both these galaxies are bright radio and X-ray sources. Studies have, however, shown that X-ray sources centred on these galaxies are more extended than the size of the galaxies. This suggests that besides the galaxies, there are diffuse sources of X-rays in these clusters. From detailed studies of the source-size distribution and spectral characteristics of X-ray emission from individual clusters, it has been now well established that the bulk of the X-ray emission from the clusters comes from a hot gas pervading the

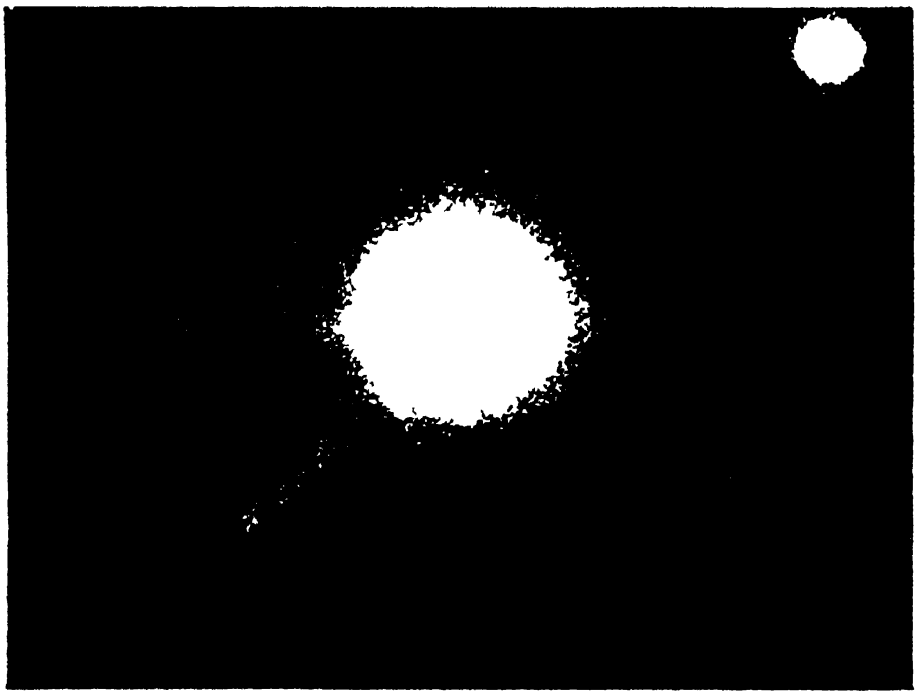


Fig 6 The quasar 3C273 appears as a 13th magnitude star-like object in this optical photograph made with the 5 00 m Hale Observatory Telescope A faint jet emerging from the object and 160 000 light-years long can also be seen clearly in the photograph Its redshift is 0 16 mplying a distance of 2 6 billion light years 3C273 was the first quasar discovered to be an X-ray source Its X ray luminosity is about three trillion times the solar luminosity The Einstein Obser vatory has now discovered that a majority of the quasars are bright X ray sources X-ray emission has been discovered from 94 quasars till January 1980

intracluster medium The temperature of this gas lies in the range of 20 to 100 million degrees in different clusters The thermal origin of the X-ray emission from clusters of galaxies is confirmed by the detection of X-ray emission lines of Iron XXIV, Iron XXV and Iron XXVI ions at 1 16 6 7 and 6 95 keV, respectively from several cluster sources An additional support for the thermal mechanism is provided by the observed correlation of the intracluster gas temperature with the velocity dispersion of galaxies in the cluster High spectral resolution observations of the galaxy M87 in the Virgo cluster made with a Bragg crystal spectrometer, have revealed the presence of an X-ray emission line of hydrogen like ions of oxygen (that is OVIII) at 0 65 keV The intensity of the oxygen line however, requires an oxygen to iron abundance ratio of seven times the cosmic value if the line arises from the same 30 million degree temperature plasma which produces higher energy lines An alternative explanation that this line originates in a cooler component of intracluster gas present in the vicinity of M87 appears more plausible The detection of Iron XVII line at 0 83 keV from the Seyfert galaxy NGC 1275 in the Perseus cluster also requires a cooler plasma around NGC 1275 These results demonstrate that the intracluster medium is not isothermal

X ray emission had been discovered from about 50 clusters of galaxies before the launch of the Einstein Observatory All these clusters are located within a redshift of less than 0 2 The Einstein Observatory has now detected X-ray emission from several more distant clusters the farthest of which (3C 343 1) has a redshift of 0 75 The characteristics of these distant clusters are however, similar to those observed for nearer clusters No evolutionary effects are discernible in the X ray data of these distant clusters

X-ray halo around M87

Maps of the X-ray surface brightness of the galaxy M87 in the Virgo clusters indicate that this galaxy possesses a gigantic dark halo which extends out to a distance of about 750,000 light years This is in contrast to its visible core size of only about 2 600 light years Independent evidence for the existence of a faintly glowing corona around M87 has been obtained earlier from optical observations On the basis of the X-ray data it has been estimated that the mass of this halo lies in the range of 17 to 40 trillion solar masses It is likely that other galaxies in the Virgo cluster, and possibly all clusters, may have similar halo around them In that case, masses of these galaxies may have been grossly underestimated Optical studies had indicated that the total mass of visible matter in several clusters like Coma and Perseus is only about one-tenth of the mass required to bind these clusters gravitationally Where the remaining nine-tenths of the cluster mass resides has been a puzzle for a long time It now appears that the revised mass estimates of the galaxies together with the mass of the hot intracluster medium will probably solve this puzzle of the 'missing mass in the clusters

Quasars: emitters of intense X-rays

Quasars occupy a unique position among all celestial objects due to their anomalously large redshifts They have been the subject of intense observational and theoretical research ever since their discovery in 1963 More than 600 quasars have been discovered till 1977 The largest observed redshift is 3 53 found in a quasar named OQ172 Quasar redshifts have been a subject of a fierce controversy among the astronomical community And the debate on the cosmological versus local interpretation of quasar redshifts still goes on (SCIENCE TODAY May 1980 p 33) However, a majority of astronomers tend to favour the cosmological interpretation of redshifts If one accepts this interpretation then quasars become the most distant and most luminous objects in the universe

Quasars also have the distinction of being the most prodigious X ray emitters Three of the nearest quasars were known to be X ray sources before the Einstein launch Among these, 3C 273 was the first to be discovered An optical image of this 13th magnitude star-like object with a jet emerging from it is shown in Figure 6 This object varies in optical, radio and X-ray bands over time scales of several months It also produces high energy X-rays of up to 100 keV Its X-ray luminosity is about 10^{46} ergs per second, which is a hundred million times the luminosity of the brightest X-ray source in our galaxy, and comparable to its optical luminosity It is this extraordinary luminosity and requirement of an energy source to power it that set quasars apart from other objects in the universe

Studies of quasars were emphasised from the very beginning of the Einstein programme This emphasis paid handsome dividends when it turned out that a majority of the quasars looked at by the Einstein are X ray emitters Till January 1980, X-ray emission had been discovered from 94 of the quasars Of these, 24 were first discovered by Einstein from

X-ray observations. Subsequent observations of the X-ray positions by optical astronomers led to the identification of the optical images of these quasars. The X-ray luminosities of these quasars are deduced to be in the 10^{45} to 10^{47} ergs per second range. These values compare favourably with the optical luminosities of the quasars For one of the quasars, OX169, intensity variations by a factor of about three in a period of less than three hours were also recorded This observation immediately suggests that the X-ray emitting volume in this quasar must be extremely small, only about three light hours (3×10^{14} cm) in size An energy source capable of producing energy at a rate equivalent to that of one hundred billion suns is required to explain the observed X-ray luminosity The only conceivable way of producing so much energy in a tiny volume is to invoke the presence of a massive black hole at the centre of the quasar Release of gravitational energy by matter falling into the gravitational potential of a black hole with a mass in the range of 2×10^6 to 3×10^8 solar masses, can explain the observed X-ray luminosity

Diffuse X-ray background

Redshifts of galaxies and quasars indicate that these objects are moving away from each other with a velocity proportional to their redshift The question naturally arises whether this expansion of the universe will continue for ever or the expansion will slow down at some distant epoch, come to a halt and then the universe will start contracting again The debate on the question of 'open' versus closed models of the universe has been going on among cosmologists for a long time The prime condition for a 'closed' universe model is the presence of sufficient mass in the universe whose gravitational pull will be large enough to slow down the expansion and bring it to a halt A 'closed' universe, therefore, requires a mass density which should be larger than a 'critical' mass density estimated to be about 5×10^{-30} grams per cubic cm (using the value of the Hubble Constant to be 50 km per second per megaparsec) However, the observed mass density of all the visible matter in the universe is about 10^{-31} gram per cubic cm It has been suggested that this 'missing mass' might be present in the intergalactic space in the form of neutral or ionised gas If there is neutral gas in the intergalactic space, then the spectra of distant galaxies and quasars should show the presence of the Lyman Alpha absorption line of atomic hydrogen No such lines have been detected indicating little neutral gas in the intergalactic medium. However if the intergalactic gas is fully ionised and has a temperature of one to several hundred million degrees, then this will radiate predominantly in the X-ray band Evidence for the possible existence of such a hot intergalactic gas has come from the study of a diffuse cosmic X-ray background whose existence has been well established from several experiments over the last 15 years

Precise measurements of the energy distribution of the diffuse X-ray background carried out recently by the Goddard Space Flight Center, USA, show that its observed spectral characteristics are best explained as diffuse thermal emission from a hot gas of about 500 million degree temperature From the observed intensity of the X-ray flux, they calculate that the mass density of this hot gas is about 36 per cent of the density required to close the universe If one accepts this result, and takes into account the uncertainties involved in the estimation of the closure density, such as the value of the Hubble Constant, then it may be concluded that after all the universe will not continue to expand for ever

However the discovery of X-ray emission from a large number of quasars by the Einstein observatory has prompted Riccardo Giacconi and his colleagues at the Harvard-Smithsonian Centre for Astrophysics, USA, to suggest that the bulk of the X ray background is not due to a diffusion-emission process but rather an integrated emission from a large number of distant X-ray emitting quasars From their derived source number-intensity relation for extragalactic sources, Giacconi and his group calculate that 37 per cent of the observed background flux could be attributed to discrete sources Further, assuming that the number of fainter X-ray quasars increases in the same manner as indicated by the quasar optical counts and assuming a definite correlation between X-ray and optical luminosities, it is estimated that quasars brighter than 20th magnitude can practically account for all the observed diffuse X-ray flux

There are, however, difficulties with the discrete sources model First, the observed X-ray to optical luminosity correlation is not very strong and, second, the energy spectra of the quasars are not well known Till now, detailed spectral data are available for only one quasar, namely, 3C273 It also remains to be seen whether the slope of the optical counts of quasars versus magnitude curve tends to flatten for quasars of fainter than 20th magnitude as required by the discrete source model to make sure that the contribution of fainter quasars does not exceed the observed X-ray background flux It thus appears that a final verdict on the 'open' versus 'closed' model of the universe must wait till more definite information is available on the X-ray luminosity function and spectral shape of quasars

With the profound qualitative and quantitative changes brought about by the Einstein observatory, the young branch of X-ray astronomy has now come of age and ranks on a par with optical and radio astronomy According to the most recent projection, the Einstein observatory is expected to remain operational till April 1982, when it will plunge into the earth's atmosphere and meet a fiery death It is hoped that continued observations with the X-ray eye of the Einstein will enable us to probe the mysteries of the farthest regions of the sky This will contribute greatly to our understanding of the structure and evolution of the universe



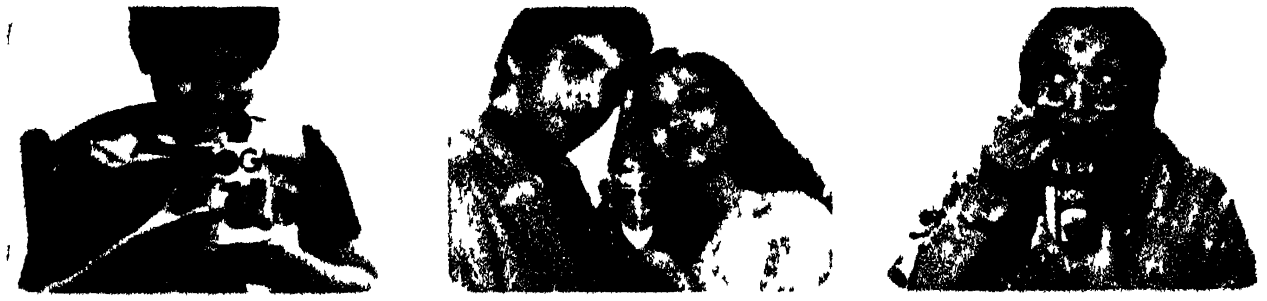
Dr Agrawal is Reader in the Space Physics Section at the Tata Institute of Fundamental Research Bombay His research interests are mainly in the area of X ray and gamma ray astronomy Dr Agrawal has been carrying on observations of X ray sources for the last 12 years using balloon rocket and satellite borne instruments He is a co investigator of the A 2 experiment on the High Energy Astronomy Observatory 1 (HEAO 1) launched by NASA in August 1977 He did research in X ray astronomy at the California Institute of Technology USA during 1972 75 and at the Jet Propulsion Laboratory Pasadena USA in 1978 80 He is also carrying out studies of X ray sources with the Einstein Observatory under the Guest Observation Program of NASA



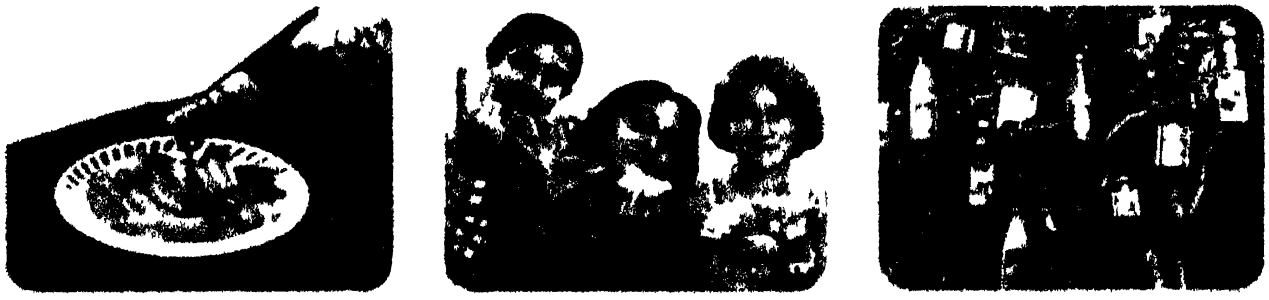
The problem to overcome is the female insects attraction towards more and more expensive perfumes each time

NOGA

It's like having an orchard in your home!



Oh, oh, oh! *It is good!* *Just the thing*



to set the mood *Do yourself* *a flavour.*

Get
NOGA
– IT'S ONLY NATURAL!

NOGA Squashes,
Juices, Jams,
Ketchup,
Canned fruits
and peas.



Maharashtra
Agro-Industries
Development
Corporation Limited
Noga Unit Nagpur

ASP/MAID/7780

FROM THE STATE
[illegible] most popular baby food

[illegible] mothers using baby food, choose Amulspray, than any other baby food. Because Amulspray is

- perfectly balanced ● vitamin-enriched
- easy-to-digest ● dissolves easily

Breast-feeding is Natural...

Remember, mother's milk is by far the best for baby. It is extremely difficult to substitute for breast milk.

All mothers, therefore, should feed their infants at the breast as long as the quantity of milk remains adequate.

However, if your breast milk is not sufficient for baby, start him on Amulspray.





Amulspray starts the growth only Balamul helps continue





3rd MONTH ONWARDS Balamul as well

No other solid food is good enough for your Amulspray baby.

Why a specially prepared, balanced, solid food after 3 months?
Because your baby is growing so fast! He doubles his birth weight in 6 months—his brain is 80% developed by three years. Milk alone is not enough. Your baby needs proteins, vitamins and minerals in a balanced form, that only Balamul ideally provides.

Balamul—specially created for the Indian baby
Balamul has been specially formulated with the help of the Central Food Technological Research Institute, Mysore and tested at the Christian Medical College, Vellore!

Balamul—more nutrition, more value

- at least 25% more protein than other branded cereal foods
- more calcium, Vitamin A and C
- fortified with balanced quantities of fat, iron and Vitamin B Complex
- pre-cooked in milk. Easy-to-digest
- delicious, mixes easily with: dal, mashed fruits, puddings

Balamul gives TWICE the value for your money than any other branded cereal foods

FREE Informative Amul Baby Book and Balamul Growth Record Booklet in English. Baby Book also in Hindi, Marathi, Gujarati, Bengali, Tamil, Telugu and Malayalam. Write to Post Box No. 10124 Bombay 400 001 with your complete address and Re 1.00 postage stamps.

Marketed by:
Gujarat Cooperative Milk Marketing Federation Limited, Anand

ASP-AB-5/79A

Shells around stars as evidence of their slow death...

STARS are born from interstellar dust and gas. Gravitational force pulls star-forming matter towards a central point. When the matter comes closer to the central point its density increases. The density and temperature soon reach a point when nuclear reaction sets in in the centre converting hydrogen nuclei into helium nuclei. The energy released from this reaction raises the temperature further and produces sufficient pressure gradient outward to stop collapse. And a star is born.

Depending on the mass of the star the energy production continues from a million to billions of years and conversion of hydrogen to helium advances towards the outer parts leaving a core of mostly helium. This helium is ignited when the temperature and density increase at the core due to collapse. The successive collapses and nuclear processes lead to a star consisting of onion like shells of hydrogen helium carbon oxygen etc. Ultimately there comes a time when no source of energy is available and a star is about to die.

The death of a star can occur in two ways: (1) violently in the form of a supernova explosion leaving a supernova remnant (SNR) and a neutron star (SCIENCE TODAY June 1980 p 26) or (2) by slowly expelling sufficient matter from its surface so that the degenerate electron pressure available at high density can balance the gravitational force of the star. In the latter case it ends up as a white dwarf living the remainder of its short life on the remnant thermal energy.

What are the observational evidences for this scenario? The observations of several clusters of stars agree well with what one expects for living stars in this scenario. The evidence of violent death of a star comes from the observation of supernovae or their remnants. The evidence of slow death has started coming only recently from the observations of absorption lines shifted shortward of their laboratory values implying outward flow of mass of gas from the stars. The existence of such mass loss from stars was also argued earlier from the observation of planetary nebulae. These are very bright stars surrounded by a shell of gas ionised by the radiation of the star. The spectroscopic study of this gas shell shows an elemental composition very similar to that of the sun with some minor differences which could be explained in terms of mixing of the inner matter and in terms of formation of grains in the shell. Therefore most of the shell material is thought to be matter ejected from the surface of the star which did not participate in the nuclear processes.

Many planetary nebulae have been seen to have more than one shell of gas. The planetary nebula Abell 30 is of this type. It has an outer shell extending up to 130 arc seconds, with a composition very similar to that of the sun. It has been observed recently that Abell 30 has also an inner shell of 25 arc second extension (G H Jacoby *Publications of the Astronomical Society of the Pacific* **91** 754; C Hazard and colleagues *Nature* **285**,463). The inner shell has four knots of bright radiation at wavelength 5007 Å. The spectroscopic studies of these knots by Hazard and his co workers at 3 400 to 5 300 Å shows emission lines of He II at 4 686 Å, Ne III at 3 869 Å and Ne V at 3,426 Å. The relative intensities of these lines are the same as in other high excitation planetary nebulae. However there is no evidence of Balmer beta line of hydrogen at 4 861 Å. This led the author to derive lower limit of the ratio He/H to be greater than 2 4 compared to the value 0 1 found in normal planetary nebulae. This could imply that the inner knots of gas in Abell 30 consist of processed material in the star and the central star is now expelling the helium shell after it had expelled the outer shell of hydrogen.

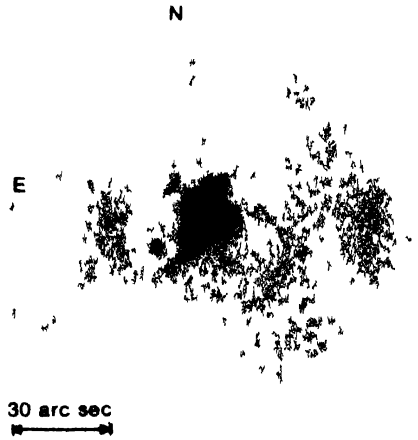
This not only supports the present scenario of stellar evolution very well but has many significant implications. First it is possible to deduce the time between two expulsions by knowing the expansion velocity and comparing the sizes of two shells. Second this implies the possibility of finding the processed material in other planetaries with more than one shell.

The study of the central star of a planetary nebula will then open up the possibility of finding the star made up of only heavy material. All these possibilities are to be proved or disproved by future observations and theoretical work.

However, all may not be as well as one hopes. It is known that there are stars with outer layers mostly of helium. These stars have possibly expelled their own shells of hydrogen during their evolution. Abell 30 is known to have a very faint companion star which could be a helium star and that matter is being transferred from this star. Even then, it is interesting because Abell 30 will be the first of this kind. Astronomers are looking forward to further developments following the discovery of hydrogen deficient circumstellar material in Abell 30.

S P TARAFDAR

Dr Tarafdar is with the Astrophysics Group, Tata Institute of Fundamental Research, Bombay.



The planatary nebula Abell 30 at wavelength 5007 A°. The very faint companion star is just visible to the south-east. The dark clover leaflike pattern around the centre is associated with knots.

... and star shells around galaxies?

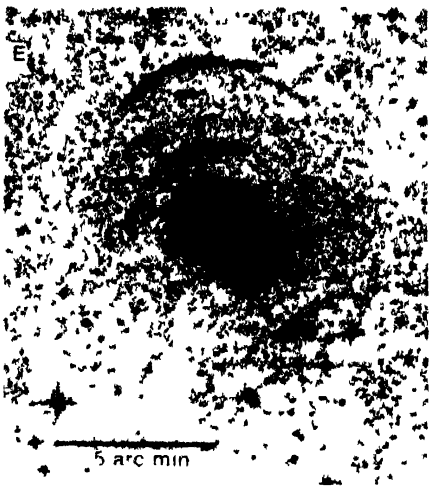
NOW comes the news of shells around galaxies. Two Australian astronomers have recently found the first optical evidence of shells of stars around normal elliptical galaxies. The presence of these shells has strong implications on the theories about the formation of galaxies and stars.

Galaxies which contain billions of stars are broadly classified into three categories (i) the irregulars like the Magellanic Clouds (ii) the spirals like our Milky Way and (iii) the ellipticals like NGC 4278. The elliptical galaxies which make up 20 per cent of the total population of galaxies look like partly flattened luminous spheres. Of course some elliptical galaxies do not confirm to the picture. For example in M89 a small finger like protrusion is visible on the flattened luminary sphere. These are termed peculiar elliptical galaxies. So far it was believed that the elliptical galaxies were free of gas and dust.

In the last year or so evidence has accrued that some peculiar elliptical galaxies have shells around them. But a remarkable feature D F Malin and D Carter of the Anglo Australian Observatory Australia, reported in a recent issue of *Nature* (**285**, 643) is the presence of shells around normal elliptical galaxies like NGC 1344 and NGC3923. What does the presence of these shells around these isolated galaxies mean? The authors examined the possibility that these shells are nothing but dust shells like the ones around stars in our galaxy. But they concluded that this is highly unlikely since if the shell were of dust, the colours of the elliptical galaxy would show peculiarities which are not observed now. Hence they concluded that these are shells of stars.

If the shells were formed *in situ* some violent shocks must have triggered a burst of star formation in an intergalactic medium. The origin of the shock is a good area of speculation. The authors attribute the shocks to the instabilities associated

with the formation of galaxies in the early universe However, it is not known for certain whether the current theory of galaxy formation is correct Further, even if one assumes that these shocks do exist in order to have star formation taking place in the intergalactic medium there should be sufficient matter density in the intergalactic region However several observations like the Lyman Alpha absorption of quasar-like objects by intergalactic medium X-ray from any possible hot intergalactic gas etc suggest that the intergalactic medium is extremely tenuous Under these circumstances the possibility of star formation taking place in the highly tenuous region looks very remote



The normal elliptical galaxy NGC 3923 showing three pairs of shells lying within the envelope of the galaxy at radii 2 3 and 5 arc minutes The shells probably consist of stars

Another interesting suggestion is that these are relics of some violent explosions in the nuclei of the galaxies old stars would be ejected from the nucleus and were ejected in unstable and fairly eccentric orbits to produce the thin shells seen

This suggestion is one by no means directly seen is highly speculative It means that the violent activity occurred in such a fashion as to produce thin shells of stars The question arises why should such a regular violent activity occur in the giant galaxy in the first place Perhaps this explanation is true in the case of peculiar elliptical galaxies where there is evidence of violent activity in the form of the protruding jet mentioned earlier rather than in for normal galaxies

Whatever the interpretation of these very interesting findings of the giant shells further elucidation of the radio properties and the optical spectra of these galaxies is likely to engage the attention of the astronomers in the near future

S RAMADURAI

S Ramadurai is with the Astrophysics Group of Tata Institute of Fundamental Research Bombay

Triple quasar—another gravitational lens

LAST year two quasars were observed in the sky very close to each other (SCIENCE TODAY November 1979 p 29) They are thought to be two images of the same object caused by the gravitational bending of light by an intervening mass Three quasars have now been found close together and are believed to be images of a single quasar again produced by the gravitational lens effect (R Lynds R Weymann and colleagues *Nature* **285** 641)

The triple quasar is designated PG 1115 +08 A B C and has three distinct images all showing the same red shift of 1 7 in their spectra (red shift is one of the characteristics of quasars) The central quasar A is the brightest (visual magnitude 15 9) while B and C which are equidistant from A are dimmer by a factor of about 15 It is suspected that there may be more than one mass concentration acting like lense to produce the triple image Quasars are one of the bright current probes in the gravitational lens in addition to aiding the images also enhances its brightness Searches are on to locate the mass concentrations acting as the lense

Observations with radio infrared ultraviolet telescopes since the discovery of the double quasar 0957 + 561 first detected by the suspicion that it could too may have two images of a triple system A galaxy which acts as a gravitational lens has already been identified (SCIENCE TODAY May 1980 p 11) A giant elliptical galaxy with a red shift 0 4 situated at the centre of the cluster was found and B of the double quasar were each by This is consistent with the observed brightness of B A = 0 5 according to the gravitational lens theory

Ultraviolet observations were carried out instruments in satellite called the International Ultraviolet Explorer indicate that the two images have the same ratio of intensities in the ultraviolet wavelength

Infrared observations indicate a larger flux from image B than from However if the infrared flux expected from the giant elliptical galaxy which near B is subtracted the flux ratio B A comes out precisely as expected

Radio observations of the double quasar show a complex structure It has a bright extended region near A nearly linear in structure making a large angle with the line joining A and B There is no corresponding image near B which is found to be a compact radio source There is a weak extension near B pointing approximately towards A This non symmetric structure is difficult to reconcile with the simple gravitational lens model

However now that the galaxy which acts as the lens has been located its mass and other properties will be determined Exact calculation of the gravitational effects based on these should lead to an understanding of the formation of the structures Meanwhile scientists are also looking for other examples of the gravitational lens effect

It is believed that out of over 1500 or so known quasars about one per cent could appear with multiple images Astronomers should now check whether faint companions of quasars are in fact cases in point This may be important because the brightness of the nearest and the most distant quasars sometimes used to estimate the size and the age of the universe If the intervening mass concentrations produce multiple images and brightness enhancement of the quasars then cosmological tests may need to be revised and find out whether it is necessary to have multiple

KRISHNA M APPARAO

Dr Apparao is Associate Professor at the Astronomy Group Tata Institute of Fundamental Research Bombay

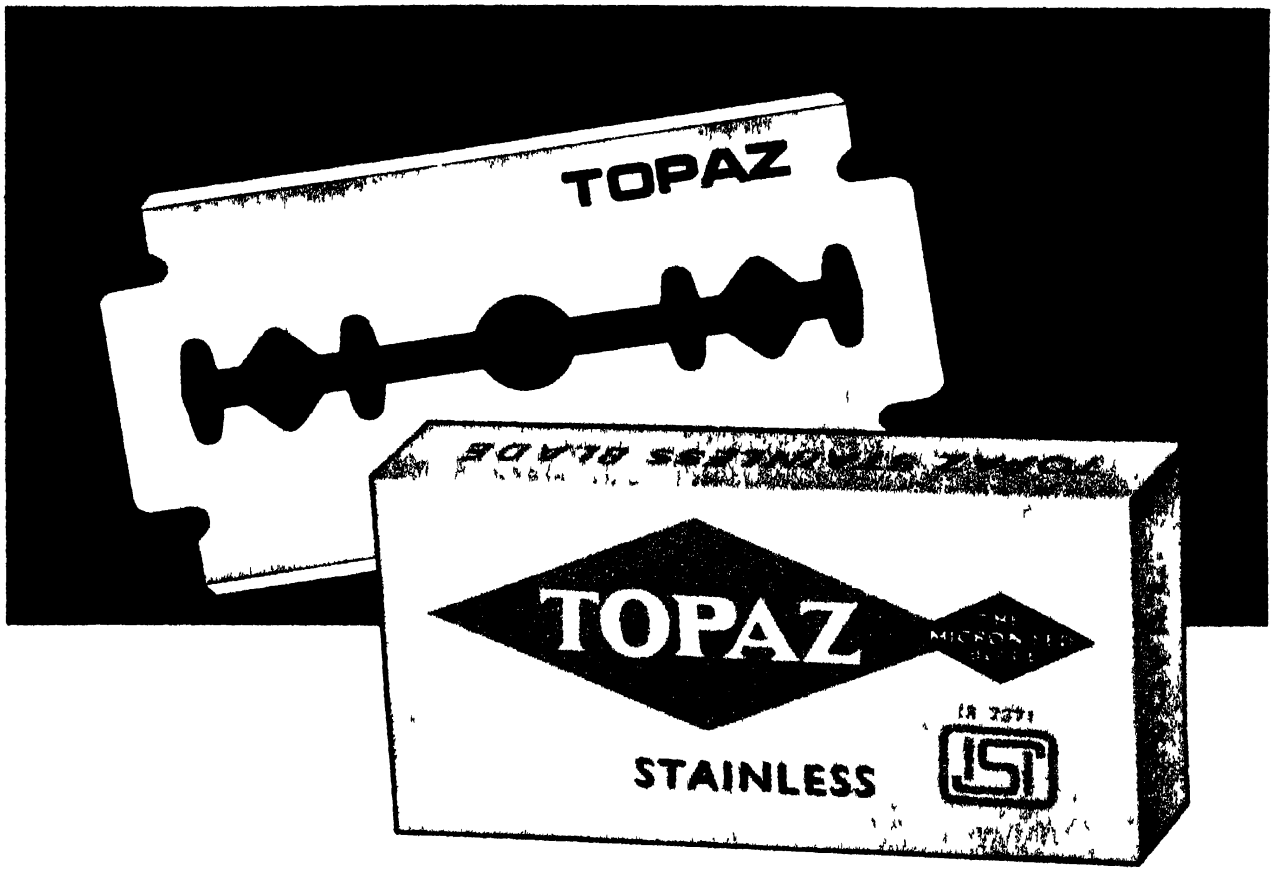
Biologically active mammalian protein from bacteria

The study of other cells by cloning DNA from the cell in the bacterium has now been extended to the production of biologically active mammalian proteins in bacteria Human interferon and human growth hormone are the first two proteins to be produced in bacteria by cloning techniques Interferon is the body's natural defence against viral infections and has been found to be effective in the treatment of certain cancers Human growth hormone is used in the treatment of pituitary dwarfism

These successful attempts to produce proteins in bacteria have been hailed as a major breakthrough in the production of medically important proteins Eukaryotic cells like those of mammals are complex in their organization and have a variety of control mechanisms that in turn give rise to a variety of products Bacteria on the other hand are relatively simple in their organization and have a limited number of products Hence the production of mammalian proteins in bacteria is a difficult task Some of the problems that researchers in this area have encountered in the past few years are worth noting

Among the many proteins that are produced in mammalian cells only a few are attractive candidates for production by cloning their genes in bacteria This is mainly due to two reasons First because all these are

India's No.1 today...
World's No.One tomorrow...



TOPAZ—the fastest growing blade in the World

Available in

Abu Dhabi • Aden • Afghanistan • Bahrain • Bangla Desh • Djibouti • Dubai • Egypt • Ethiopia • Fiji • Great Britain • **India** • Iran • Jordan • Kuwait • Lebanon • Libya • Malawi • Malaysia • Morocco • Nepal • New Zealand • Nigeria • Pakistan • Saudi Arabia • Sierra Leone • Singapore • Somalia • Spain • Sudan • Syria • Taiwan • Thailand • Yemen • Yugoslavia • Zaire.

No wonder More & More people choose

TOPAZ

The all time Leader

A MALHOTRA QUALITY PRODUCT

2480

normally small polypeptides for which the DNA sequences can be relatively easily synthesised chemically or from the complementary mRNA with the help of the enzyme, RNA-dependent-DNA-polymerase (reverse transcriptase) Second, because in nature these chemicals are present in very small concentrations and are very expensive to isolate Indeed, some like the species—specific human growth hormone (hGH) can be obtained only from human cadavers It is therefore not surprising that the brain hormone somatostatin a polypeptide made of only 14 amino acids (AA), was the first medically important mammalian product to be produced by gene cloning in *E coli* This was followed by the bacterial synthesis of hGH and insulin These hormones were produced by inserting the DNA sequence coding for them inside specific bacterial genes which were then transcribed and translated to produce composite protein The latter had the polypeptide sequence of the hormone inserted inside the bacterial protein The hormonal polypeptide cleaved out of these composite proteins by hydrolytic manipulations had been shown to be immunologically similar to the natural products but their biological activity had not been demonstrated

John Baxter and his colleagues have now published (*Nature* 285, 456) the first case of cloning in *E coli* of a mammalian gene (beta endorphin) which is expressed to produce a biologically active product Beta endorphin is a pituitary hormone which is present in brain and acts as an endogenous opioid Among opiate peptides beta endorphin is the most potent in every biological system and has analgesic activity It is generated by processing of a large polypeptide which is a precursor to several other pituitary hormones including adrenocorticotropic hormone (ACTH) beta lipotropin (beta LPH) and melanocyte stimulating hormone (beta MSH) (SCIENCE TODAY April 1979 p 27) Starting from mRNA coding for the mouse ACTH beta LPH precursor protein Baxter's colleagues had earlier synthesised the complimentary DNA (cDNA) with the help of RNA dependent DNA polymerase and cloned a fragment of this DNA which contained information for 47 amino acids 30 of which comprised complete beta endorphin sequence (31 amino acids long) minus one C terminal AA glutamine Now the same group has modified this cloned DNA fragment to insert the codon CAA for the C terminal glutamine and a stop codon TGA Then they fused this fragment inside the bacterial betagalactosidase gene carried on a plasmid (taking care that the frames of the two sequences during translation were the same) and introduced the recombinant plasmid into *E coli* by transformation A hybrid of beta galactosidase, beta MSH and beta-endorphin polypeptide sequences was produced by these transformed cells Beta-endorphin was released from the hybrid protein by a series of clever chemical manipulations

The beta-endorphin thus made was immunologically as well as biologically active in *in-vitro* tests With the production of beta-endorphin in *E coli* the way is now open to consider its use for clinical purposes as large quantities will not be difficult to obtain Among the possible uses are treatment of pain, diarrhoea or psychiatric problems

S K MAHAJAN

Dr Mahajan is with the Genetics Group Bhabha Atomic Research Centre Bombay

Largescale production of interferon

INTERFERON mediated interference is one of several mechanisms through which the cell resists the entry and replication of a remarkable number of viruses The others include the intrinsic defective particle and site specific types of interference Another the plasma factor type which is briefly described here Still the interferon mediated type of interference has again come into the limelight of biomedical research since of all antiviral compounds the most promising are the interferons for they are natural products which are not antibodies and are produced by almost all cells They constitute the first line of cell mediated defence against viral invaders being produced by the cell much earlier than the second line defensive proteins the antibodies (SCIENCE TODAY February 1980 p 27) and are remarkable because of their low immunogenicity rarity of side reactions and broad spectrum of anti viral action Indeed they may ultimately well be the answer for the prevention and therapy of a large number of viral diseases However, it is the largescale production of interferon which has been —and continues to be — the greatest problem faced by scientists Another major drawback of the interferons is their species specificity that is only human origin interferons are optimally effective for the treatment of human viral infection

The early approaches to interferon therapy included the stimulation of endogenous human interferon through the use of non viral inducers including the synthetic double-stranded RNAs and bacterial endotoxins Today however, the emphasis is on exogenously-prepared human interferon Since 1976, systematic studies were initiated in the West to test the utility of exogenous interferon preparations in several diseases like herpetic keratitis, cytomegalovirus inclusion disease, the respiratory diseases, German measles and tumours such as multiple myeloma, carcinomata of the cervix and breast and Hodgkin's disease Encouraging results have been obtained Most of the clinical studies using human leucocyte interferon induced by viruses were by Dr Kari Cantell of Finland, the pioneer in the field of largescale production of interferons In 1978, his laboratory produced 5000 litres of crude interferon, containing approximately one hundred thousand million units Following purification, even this amount was grossly inadequate to meet the global demand of patients

A plausible approach for producing large quanta of human interferon is the utilisation of the high biosynthetic protein-producing machinery of the prokaryotic bacterial cell This involves the currently popular technology of genetic engineering (recombinant DNA) C Weissmann, Cantell and their colleagues have, very recently announced their successful cloning of an interferon gene into *E coli* However of the major difficulties anticipated by researchers in DNA recombinant research is the lack of carbohydrate in the interferon produced by bacterial cells— the carbohydrate moiety is believed to be essential for longer survival of interferons in the human body The purification of interferon to the homogeneity level has been recently claimed and also the amino acid composition and sequence of 20 N terminal amino acids have been presented Scientists now possess interferon preparation with highly impressive biological activity for example, a preparation with an activity of 2×10^8 reference units per milligram of protein would mean that the 500 litre crude interferon of Dr Cantell would contain only a tenth of a gram of pure interferon!

An elegant step towards the production of large volumes of highly specific anti-interferon antibody to be used in obtaining highly purified interferon preparations was taken by D S Secher and D C Burke (*Nature* 285 446) These investigators immunised mice with crude interferon When anti interferon antibodies developed splenic cells from these animals were fused with those of mouse myeloma (a plasma cell tumour), using Sendai virus The hybrid immune cells were screened for anti interferon antibody by a modified Jerne's plaque assay technique Specific antibody producing cells were thus cloned and grown in mass culture Because the antibody was now a product of a transplantable tumour, there was no limit to the highly specific antibody that could be made, without further need for interferon as an immunogen The cells, when injected subcutaneously in mice, produced tumours and the serum of such animals contained large volumes of anti-interferon antibody Using this monoclonal (single cell) antibody in an affinity chromatographic procedure a 5000-fold purified product could be achieved in a single step The important advantage of this monoclonal antibody is that it should be equally applicable to interferon purification from human leukocytes as well as from cloned *E coli* producing human leukocyte interferon

At present, all interferon assays are based on its biological activity The availability of monoclonal antibody would be extremely useful for *in vitro* tests for interferon, such as radioimmunoassay, which will be highly desirable for the detection of minute amounts of interferons in human subjects and for standardisation of interferon preparations Further once highly purified interferon preparations become available in sufficient quantities using the monoclonal antibody employing the modern technology of protein chemistry elucidation of the structure and active cell binding site of the interferon molecule could be accomplished, this in turn making it feasible to synthesise the molecule

At present active research in the interference and interferon fields is being conducted at the National Institute of Virology, Pune and the Central Drug Research Institute Lucknow At the Haffkine Institute potent antiviral activity against a chicken tumour virus Rous sarcoma virus has been demonstrated in chickens following rabies virus inoculation Intense current activity is in progress to characterise these proteins which do not at present appear to resemble the typical interferons

M V N SHIRODKAR
J M DESHPANDE

Dr Shirodkar is Head Department of Virology Haffkine Institute Bombay and Mr Deshpande also of the Haffkine Institute is Senior Research Fellow Both are actively involved in host virus interactions involving hepatitis B virus and interference phenomena

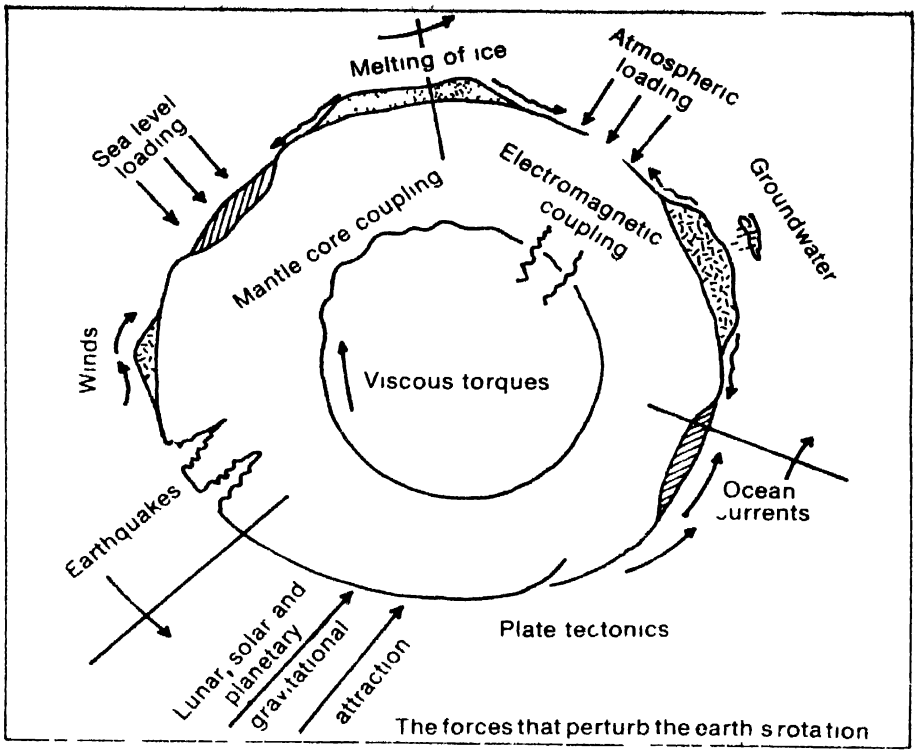
Atmospheric circulation and day length

CHANGES IN the length of day as a result of fluctuations in the earth's rate of rotation have been observed by several astronomers These fluctuations are small and are attributed to various factors such as tidal torque due to the moon sun and planets coupling between mantle and core and a redistribution of mass within the atmosphere oceans and the earth Three major components which have been recognised are (1) a steady increase in the length of the day by about 2 milliseconds per century (2) seasonal fluctuations of about a millisecond and (3) less regular fluctuations of up to about 5 milliseconds having time scales of the order of years (the so called decade fluctuations) The earth moves slowly in the spring and early summer in the northern hemisphere and fast in the autumn A complete understanding of this subject requires a better knowledge of various effects such as atmospheric and oceanic circulation earth's elasticity magneto hydrodynamics of the core and solar influence on the atmosphere

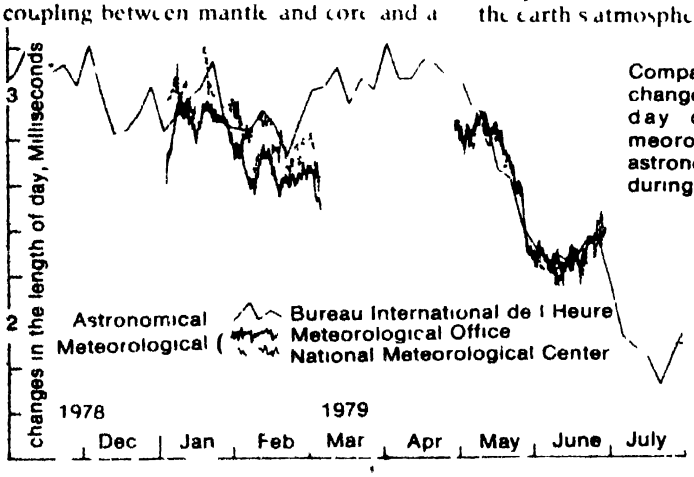
The contribution of the atmosphere to the perturbation of rotation as a consequence of an exchange of angular momentum between the earth and the atmosphere, has long been recognised All components of the angular momentum of the earth's atmosphere exhibit fluctuation due to changes in the pattern distribution and strength of winds and these will be associated with changes in the rate of rotation of the underlying mantle and with the movement of the poles (wobbles) The likely connection between zonal winds and the length of day has long been appreciated but the earliest studies were handicapped by lack of reliable and complete wind data Now as a result of GARP (Global Atmospheric Research Programme) it has become possible to make a close comparison between length of day fluctuation and zonal wind distribution obtained at 12 hour intervals during the two periods 4 January to 5 March and 1 May to 30 June 1979 R Hide and Co workers (*Nature* **286**, p 114) conclude that there is a good agreement and confirmation of the fact that the atmosphere makes a significant contribution to the changes in length of day A decrease of 20 per cent of the relative angular momentum of the atmosphere during the second half of May 1979 was accompanied by decrease in length of day by 0 6 milliseconds This has been achieved after allowing for all significant tidal effects The importance of their work lies in the fact that by continuing the surveillance of the atmosphere it should be possible to subtract the changes in the angular momentum of the atmosphere from the astronomically determined changes in the angular momentum of the mantle and thus find the residual changes due to the interaction between the mantle and the core

PREM SAGAR

Dr Sagar is a visiting scientist with the Physical Research Laboratory, Ahmedabad



The forces that perturb the earth s rotation



Comparison of the expected changes in the length of the day derived from the meorological results and astronomical measurements during 1978 79

Understanding the earth's climate

Shashi K Gupta

What controls our climate and which way it will go next

SEVERAL severe droughts and equally devastating floods have been witnessed in India and abroad during the past few decades. These climate-related calamities have had serious consequences on agriculture and the general welfare of the population. Climatic changes have often accentuated socio-economic problems and the resultant political strains. The consequences of climatic anomalies have therefore drawn the attention of the governments of the world and much more support has been forthcoming for the efforts of the scientific community towards understanding the mechanisms of the climate and its variations.

It is, however, only a theory of climate which can simulate long term trends that can provide a foundation for shorter-term predictions. Recent efforts concentrate on finding a comprehensive model for the physical basis of climate variations. Building a mathematical and sufficiently precise model is the challenging task of the immediate future.

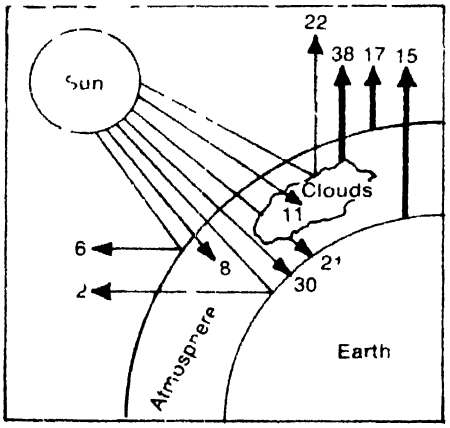
Long term variations of the climate are more spectacular than short term fluctuations. During the last Ice Age about 20 000 years ago, kilometre thick sheets of ice had covered the northern hemisphere as far south as 40°N latitude. It is not however necessary to go back as far as that. Even after the retreat of these ice-sheets about 10 000 years ago, there have been significant climatic variations. Within the span of written history, the relatively mild climate about 1000 years ago permitted Viking exploration of the North Atlantic region. A few centuries later, the little ice age (from about AD 1550 to 1750), resulted in the abandonment of Norse colonies in Greenland and brought great suffering and deprivation to Europe. A warmer climate returned in the later part of the last century and continued to improve during the early part of the present century. The optimum condition occurred in the 1940s. Since then, there has again been a gradual cooling at high latitudes in the northern hemisphere. In fact, looking further back into the distant past, there is considerable geological evidence that our planet has been through vastly different phases, some warmer and some much cooler than the present climate.

The present mild climate is not characteristic of all periods in the earth's history. It is possible though not very probable that within the next century the earth will warm up to such an extent that large quantities of polar ice will melt, resulting in a considerable rise in the mean sea level and inundating all coastal areas of the world. However, it is also possible that the earth will cool significantly resulting in enlarged polar ice-caps and thus adversely affecting the habitability of the high-latitude regions.

Such climatic variations in the past have occurred due to natural causes. There is now a growing realisation that climate at least on a regional scale can also be affected significantly by human activities. The most important human activity from this point of view is industry which injects large amounts of chemically and radiatively active pollutants (gaseous as well as particulate) into the atmosphere. For example, the extensive burning of fossil fuels during the past several decades has led to a considerable increase of carbon dioxide as well as aerosols in the atmosphere.

Physical basis of climate

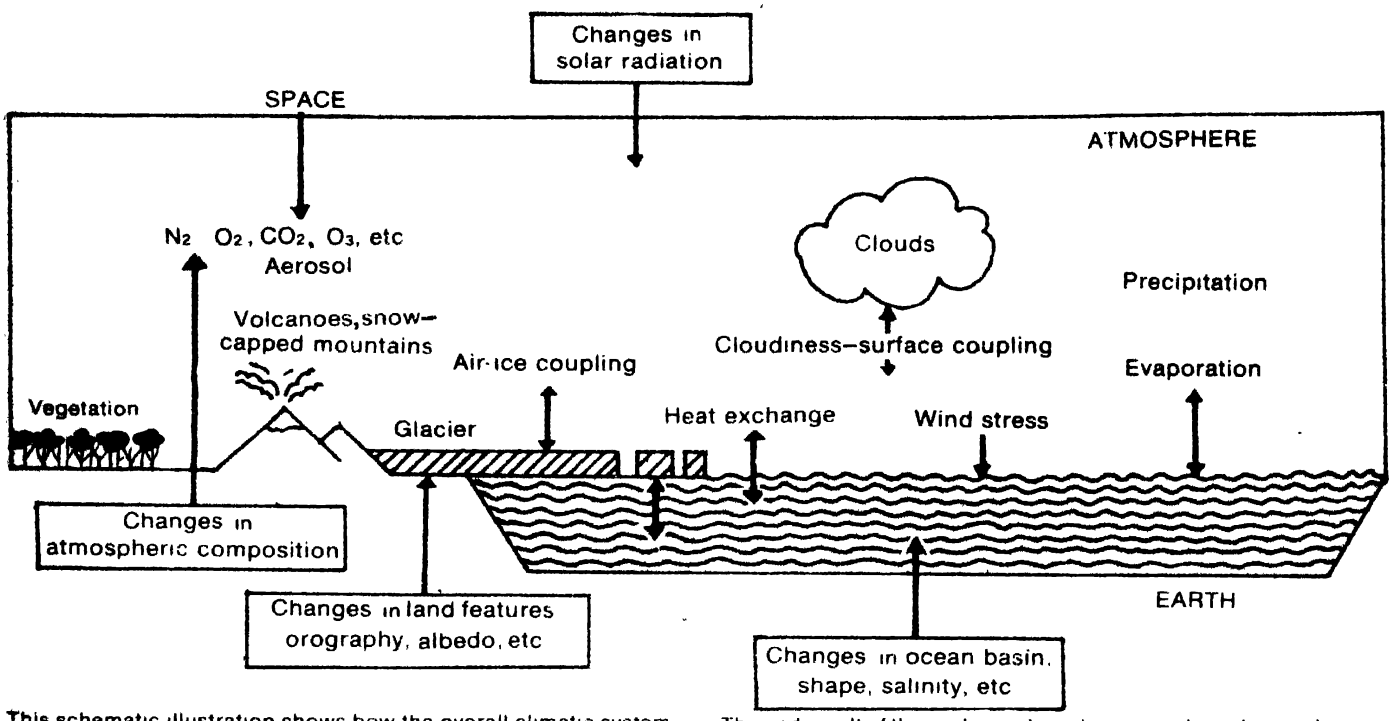
Before discussing the physical basis of climate it is necessary to explain the important terms used in this area and describe briefly the basic processes which determine the climate of the earth. The single most important indicator of the climate of a planet is its surface temperature. The only source of energy for our planet, which heats the surface and the atmosphere and drives all atmospheric and oceanic circulations is solar radiation. The sun radiates as a blackbody with a temperature of about 5800°K. This implies that about 99.5 per cent of the radiant energy coming from the sun lies in the 0.2 to 5.0 microns region. This solar radiation is also called the short-wave radiation. Approximately 30 per cent of the solar radiation which is incident at the top of the atmosphere is reflected into space by clouds, atmospheric gases and particles and the earth's surface. This reflected fraction of light is called the earth albedo. The remaining 70 per cent of the solar radiation is absorbed by the clouds, atmosphere (mainly by ozone and water vapour) and the surface (land and ocean) and goes towards heating them.



Radiation balance of the earth atmosphere system. Thin lines represent the incoming and reflected solar radiation. Thick lines show the outgoing infrared radiation.

The heated clouds, atmosphere and surface also radiate back to space, corresponding to their own temperatures. The amounts of energy radiated back by them are approximately 38 per cent, 17 per cent and 15 per cent of the incident solar energy, respectively. This radiation in contrast to solar radiation falls almost entirely in the infrared region with more than 99 per cent in the 5 to 100 microns region. This is also termed terrestrial radiation or long wave radiation. The temperature and therefore the climate of the earth-atmosphere system is maintained by the balance between the incoming short wave radiation and outgoing long-wave radiation. (The radiation balance of the earth atmosphere system is depicted alongside.) All natural and anthropogenic (man-made) factors which influence the climate do so by altering this radiation balance.

A large part of the infrared radiation initially emitted by the earth's surface is first absorbed by several atmospheric gases mainly water vapour and carbon dioxide. This energy is re-radiated by them but at atmospheric temperatures. Since the temperature in the atmosphere is much less than at the earth's surface, the energy radiated by the atmosphere is also much less than the energy that it received from the surface. This trapping of surface radiation by the clouds and infrared absorbing gases of the atmosphere is called the greenhouse effect". The presence of infrared-



This schematic illustration shows how the overall climatic system is a result of the interaction of solar radiation with components of the coupled atmosphere-ocean-ice-land-surface-biomass system

The end result of these physical mechanisms when observed over a short period of time (a few days) is called weather and when viewed over a long period of time, climate

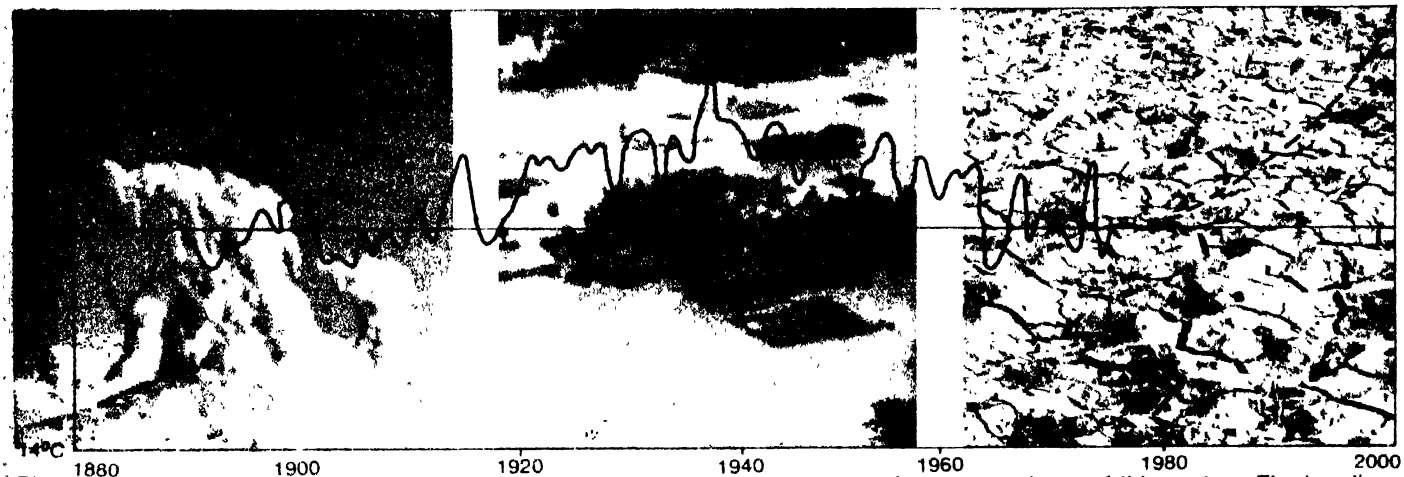
absorbing constituents thus increases the temperature of the earth-atmosphere system through the greenhouse effect.

It is apparent from the above discussion that there are three fundamental determinants of the climate system: (i) solar radiation which determines the total energy input into the system, (ii) chemical composition of the atmosphere which controls the absorption of solar radiation as well as the greenhouse effect in the atmosphere, and (iii) characteristics of the surface which determine the albedo and absorption properties of the surface.

The global-annual average temperature of the earth-atmosphere system remains constant. This indicates that in terms of global-annual averages, the earth-atmosphere system is in exact radiation balance, that is the short-wave radiation absorbed by the system is exactly balanced by the emitted long-wave radiation. This is not true, however, on smaller space or time scales.

Spatially, the equatorial regions, where the sun's rays fall direct, receive considerably more short-wave radiation than is radiated from there in the long-wave region and thus have a positive radiation balance. The polar regions, on the other hand, where the sun's rays are very slant, radiate more than they receive from the sun and have a negative radiation balance. This results in an overall heating at the low latitudes, cooling at the high latitudes and an equator-to-pole temperature gradient. Heat flows from equatorial to polar regions through the oceans and the atmosphere to establish a thermal equilibrium. This flow of energy, coupled with the rotation of the earth, is the driving force behind all motions which we recognise as winds and ocean currents.

Heat transport in the oceans is accomplished by currents like the Gulf Stream in the Atlantic, which carries warm water from the gulf of Mexico to the western coast of Europe and thus considerably influences the climate of Western Europe. In the atmosphere, heat is transported in two forms—sensible and latent. When warm air is directly transported



Global-annual average surface temperature variations of the earth for the past 100 years. The broken curve shows the expected rise in temperature during the remainder of this century. The baseline (15°C) is the present global-annual mean

to a cold region, this is called the transport of sensible heat. Water vapour which takes up latent heat during evaporation and releases it during condensation is also transported by the atmosphere. When water vapour, carried by the atmosphere, releases latent heat at high latitudes through precipitation, it constitutes the transport of latent heat. At 30° N and S latitude circles, each of the three processes discussed above accounts for about one-third of the total energy transported from equatorial towards polar regions.

Feedback mechanisms

To study the sensitivity of the climate to a change in one or more of the variables, it is first necessary to evaluate the effect of this change on the radiation balance. However, the climate system being much more complex, many interacting processes (often called the feedback mechanisms) are also operative. Thus, a primary change induced in the system may affect several other processes and, in turn, may itself be affected by them. Some of these interactions act to dampen the original change (negative feedback) while others amplify the original change (positive feedback).

A few illustrative examples of feedback mechanisms which are important in shaping our climate are:

(a) *Temperature-radiation coupling*: The surface and the atmosphere radiate in the infrared corresponding to their temperatures. If the energy input to the earth-atmosphere system is increased, the temperature of both the surface and the atmosphere increases. This rise in temperature is accompanied by an increase in the infrared energy radiated by the surface and atmosphere. This tends to limit the rate of increase of temperature. This stabilises the temperature response of the earth-atmosphere system and can be identified as a stabilising or negative feedback mechanism.

(b) *Snow and ice cover-albedo-temperature coupling:* This coupling apparently seems to have a positive feedback mechanism. More of the incident radiation is reflected back by snow and ice than by land and water surfaces. The high albedo of snow and ice in comparison with water-land surface is the dominant factor in determining the climate of the polar regions. The extent and duration of snow and ice cover in the polar regions strongly depend on the surface temperature. A decrease of planetary temperature would lead to a larger and longer lasting snow and ice cover, which in turn would cause an increase in the planetary albedo. This increase in albedo would further



Is this how the earth looked during an ice age? Such drastic climatic changes have also been responsible for the coal and oil deposits of today

The past is the key to the future

THE WEATHER, they say, is unpredictable. What about the climate? After all, the climate consists of the long-term manifestations of weather. One may well ask why should we be concerned about causes of long-term climatic changes which are not of immediate relevance? This is because the knowledge of the long-term fluctuations indicates how fast, how long and up to what extent climate can change due to natural causes. The records indicate that there have been rapid climatic changes in the past. Such changes if they occur now will have a catastrophic impact on the human population.

It is impossible to have access to very old meteorological evidences, since scientific meteorology was ushered in as late as the seventeenth century when Galileo invented the thermometer and Torricelli, the barometer. We can infer the climatic changes in the past from geological studies suggesting changes in terrestrial morphology, sediments and flora and fauna. These studies reveal that during the major part of the earth's history, the polar areas have been free of ice. The average global temperature was close to 22°C. But there have been several periods (Ice Ages) at time intervals of hundreds of millions of years, each lasting several millions of years when the poles were covered with ice. The Ice Ages themselves consisted of periods of alternating colder (glacial) and warmer (interglacial) phases. For the last 10,000 years, we are in an interglacial phase. The average global temperature is around 14°C. Noah's flood may have after all been due to a large climatic fluctuation leading to a glacial surge and not due to rain.

Why does climate fluctuate so much? The major cause of such extreme changes in climate has been attributed to variations in solar radiation incident on the earth and the modifications within and among various interacting constituents and systems of the earth brought about by solar radiation, that is, the atmosphere, the oceans and the land mass. The word climate is derived from the Greek *klima* which means inclination of the sun's rays. Measurements of the isotopic oxygen content of fossil plankton from the samples of the deep-sea sediment reveal that in the past two million years, the Ice Ages could have been triggered by four types of periodic changes in the earth's orbit around the sun, which in turn affect the amount of sunlight reaching the earth. These four cycles have periodicities of 23,000 years, 41,000 years, 93,000 years, and 413,000 years. The shorter two of the cycles are associated with the precession and tilt of the earth's rotation axis. The third cycle is correlated with the orbital eccentricity, the orbit becomes elliptical from near circular in a period of 93,000 years. But when the earth is at a maximum distance from the sun every 413,000 years, maximum ellipticity is achieved.

These four cycles are not in harmony. They are superimposed on one another like notes in a chord of music. There are also noises in the system, for example, the sunspot cycle.

There have been suggestions that there could have been other extra-terrestrial causes of climatic fluctuations, such as a sudden and abnormal influx of extra-terrestrial material into and around the earth.

The more down-to-earth causes of climatic modulations could be attributed to mountain building (formations), continental uplift and drift, change in the extent of polar ice sheet and volcano eruptions. Climate is also strongly influenced by ocean surface temperature anomalies which can be initiated by changes in salinity of the oceans.

JYOTI NEVATIA

decrease the amount of solar energy absorbed in the earth-atmosphere system and cause a further lowering of the surface temperature

(c) *Cloudiness-surface temperature coupling* Clouds are good reflectors of solar radiation An increase in cloudiness thus, causes a decrease in the solar radiation received at the earth surface, which leads to a lowering of the temperature of the earth-atmosphere system Clouds however are also excellent absorbers of terrestrial radiation This infrared absorption by the clouds, on the other hand, prevents the escape of terrestrial radiation and thus leads to an increase in temperature Because of these competing effects, we are not yet able to determine the nature of the effect of this feedback mechanism even though it may be very important The net outcome of this coupling will probably depend on the geographic distribution of cloud amounts, cloud heights and their optical properties

The interactive role of such feedback mechanisms in shaping our climate cannot be overstressed The models of climate, in order to be realistic, should include all possible mechanisms of this type

Models of climate

To make a quantitative evaluation of the effects of variations of the various determinants of climate, mathematical models of the climate system are necessary These models are essentially a set of mathematical relations representing the physical processes governing the climate in accordance with the relevant physical principles Depending upon the number of physical processes and the number of spatial dimensions they take into account, available models of climate vary greatly in their complexity The three spatial dimensions in this case are identified as altitude, latitude and longitude Some one-dimensional models consider only variations with altitude The other type of one dimensional models consider variations with latitude only The two- and three-dimensional models take into consideration variations in other dimensions as well We shall discuss here only the one-dimensional models and the results that can be obtained from them

Let us, first, consider the global average models These are among the simplest type of climate models In these only the altitude variation of parameters is considered The input is the global-annual average values of the physical parameters and the output is usually the global-annual averages of surface and atmospheric temperatures Although solar radiation incident at a place on the earth is a function of its location on the globe and the time of the year, in these models solar radiation is assumed to be uniformly distributed Thus, the atmospheric and oceanic circulations driven by differential heating of the globe and consequent equator-to-pole energy flow cannot be included in these models As a result, these global average models are useful in simulating only certain aspects of the global climate and man's impact on it They are specially valuable in the determination of the initial effect of any changes in chemical composition of the atmosphere on a global scale and have been used extensively for that purpose

The other type of one dimensional models is the surface energy balance models Latitude is the only dimension considered in these models The earth is divided into a number of latitudinal belts or zones and the physical variables like heat fluxes are obtained from a knowledge of the surface temperature These models have been extremely useful in examining the coupling between latitudinal variation of temperatures and temperature-dependent albedo

The poleward transport of energy by oceans and atmosphere is modelled in terms of zonal surface temperatures as the parameter These models are also sometimes called semi-empirical models since the temperature dependence of albedo and horizontal energy transport as well as vertical heat fluxes are generally derived from empirical relationships These models can also be used to investigate the effects of various feedback mechanisms Being empirical models, they do not, however, adequately include the effects of certain types of couplings, where changes in the atmospheric motions and transport of heat could occur as a result of changes in the radiation balance

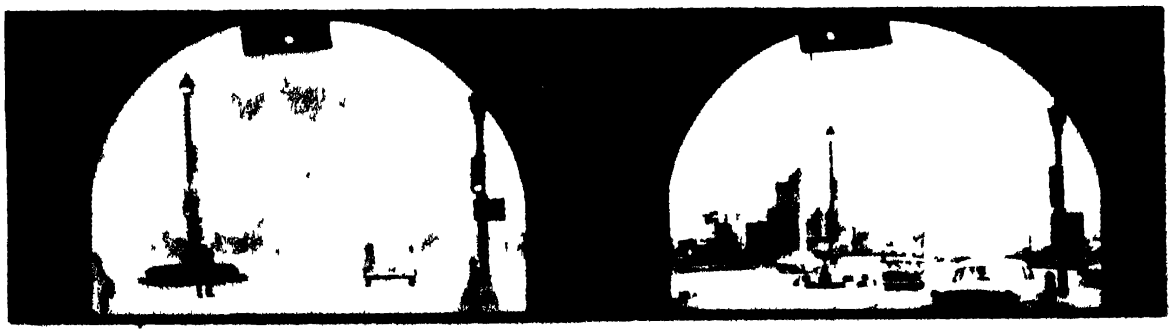
Factors affecting climate

The climate models formulated above can be used to examine the effects of changes in solar radiation, chemical composition of the atmosphere as well as the characteristics of the earth's surface These changes may occur due to either natural causes or human activities Of a large number of these factors, we shall consider mostly those which are of importance for the near future (about a century)

(a) *Change in solar radiation* This is a probable natural change even though there is not much possibility of the sun's radiative output changing substantially in the near future Several model studies have been performed to evaluate the effect of a change in the solar output and the consensus is that a two to three per cent decrease in solar output is enough to trigger an ice-age on the earth An increase of similar magnitude in the solar output, on the other hand is considered enough to melt the polar ice-caps and cause a substantial rise in the mean sea level over the globe It is estimated that a one per cent increase in the solar output will cause a rise of approximately 2°K in the average value of surface temperature

(b) *Carbon dioxide content of the atmosphere* Fossil fuels are being burnt at a tremendous rate since the beginning of the industrial revolution and large amounts of carbon dioxide have been released into the atmosphere This is responsible for the observed increase in its concentration during the present century With increased use of fossil fuels, the concentration of carbon dioxide is expected to increase by about 25 per cent by the end of the present century and to approximately double its present concentration by the middle of the next century

Since carbon dioxide shows a strong greenhouse effect, an increase in its concentration would lead to an



Right the polluted city of Pittsburgh USA in the mid 1940s *Extreme right* after the smoke control programme (in 1970) helped to clear up the city

increase in surface and atmospheric temperatures. It is estimated that this build-up of carbon dioxide will cause the surface temperature to rise by about 1°K by the end of this century and by about 3°K by the middle of the next century. It is estimated further that, if all economically recoverable deposits of fossil fuels are burned within the next few centuries, the carbon dioxide concentration could go up five to eight times its present value. For this level of carbon dioxide, the surface temperature will be approximately 5 to 6°K higher than the present value.

(c) *Aerosols concentration in the atmosphere :* The suspended particles in the atmosphere, called aerosols, also have an important effect on the climate. These particles in the atmosphere may come from natural as well as anthropogenic sources. The largest natural source is the windblown dust. Other major sources are sea-salt spray, forest fires and other open fires. Major anthropogenic sources of aerosols are sources like industry, power generation, and automobiles. Coal burning produces soot particles and trace quantities of sulphur dioxide which converts to sulphates by oxidation. Natural as well as anthropogenic hydrocarbons also produce aerosols through complex photochemical reactions. Volcanic eruptions are an important source of aerosols in the stratosphere.

The recent eruption of Mt. St. Helens in the United States has injected large quantities of aerosols into the atmosphere. It has aroused the interest of climate scientists worldwide and it is understood that several research projects have already been initiated to assess the climatic effects of this event on regional and global scales.

Aerosols scatter as well as absorb solar radiation. This leads to opposite effects. Scattering increases the effective albedo of the planet and thus decreases the solar energy absorbed by the earth-atmosphere system, causing an overall cooling. If, however, the absorption were large, it would cause an overall heating. Based on the available observations, it is believed that the former cooling, due to scattering, is the predominant effect of the build-up of aerosols. Since aerosol concentrations are also increasing on a global basis, their effect is likely to offset, at least, partially, the warming due to an increase in carbon dioxide.

In addition, there are other minor factors which may have a significant effect on the climate in the near future. Warming due to increasing concentrations of other greenhouse



Mt St Helens photographed at 18,300 m by a NASA aircraft on 19 June Dust and gases from this volcano which came to life in late March are expected to spread over much of the earth This will certainly mask carbon dioxide induced climatic changes in the near future

gases like CFMs (chlorofluoromethanes) and nitrous oxide may also become significant. Land-use patterns will also have significant effect on the climate. For example, when large forests are cleared for agricultural use, it usually results in a substantial increase in the albedo of the region and will affect the radiation balance of the region. On the other hand, damming of rivers to create large reservoirs of water leads to a decrease in albedo and will have an opposite effect.

Predictability of climate

It will always be difficult to predict the course of climate far in advance, even with the best of models. This is so because there will always be large random fluctuations in the system which make the prediction unreliable. However, for the remainder of this century and most of the next, the expected trend seems to be that of warming. It is unlikely that the warming, mainly due to greenhouse effect of carbon dioxide, will be completely masked by natural fluctuations or by the cooling due to aerosol build-up. An approximate rise of temperature of 1°K by the end of the present century and another about 2°K by the middle of the next century seems a real possibility. This may, however, be completely offset by a high level of volcanic activity.

The expected warming of the earth's climate offers some interesting prospects. In the high latitude regions, where agricultural activity is not possible during winter, a 1°K rise in temperature will lengthen the growing season by about 10 days. A rise of 1°K in average global temperature, which will be accompanied by a rise of 2 to 3°K at the high latitudes, will thus considerably increase the length of the growing season and have a favourable effect on the agricultural yield. On the other hand, this temperature rise will also be accompanied by substantial melting of ice and snow at high latitudes. The Greenland ice mass is equivalent to approximately 7 m of ocean water (average global rise) and the East Antarctic ice mass, which is by far the largest on the globe, is equivalent to about 70 m of ocean water. Any substantial melting of these ice masses can cause a considerable rise in the mean sea level and can easily inundate the coastal areas of the world

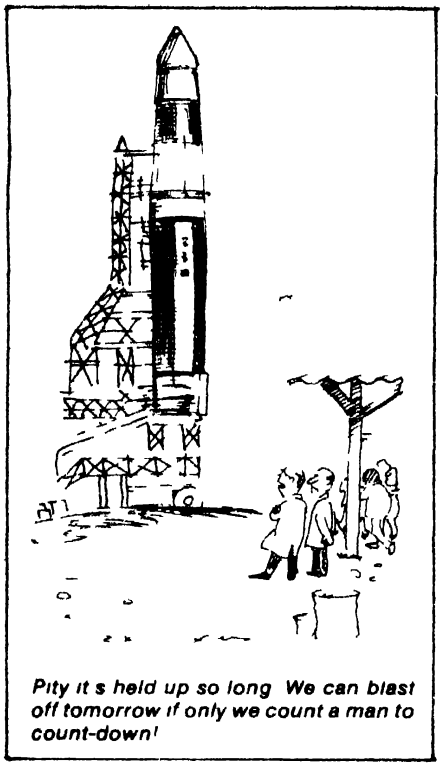
The information which has become available as a result of modelling studies of climate is extremely important. If it is realised at any stage that the expected warming at any time in the future is going to be unacceptably high, a determined international effort could possibly be mounted to stop this trend or even to reverse it. These studies afford an opportunity, for the first time in the history of mankind, where the detailed environmental impact of certain human activities can be evaluated in advance and, if necessary, checked in time before much damage is done. Keeping in mind how helpless we have been in face of the vagaries of climate throughout the history of mankind, this will be no small achievement.



Dr Gupta, who did his Ph D from the University of Allahabad, is a pool officer with the Radio Science Division National Physical Laboratory, New Delhi where he is working on the modelling of radiation transfer in the atmosphere and climate modelling He has worked on theoretical as well as experimental problems in atmospheric physics at the NASA Wallops Flight Center and was for four years at the Old Dominion University, Virginia (USA)

Further reading:

1. *Weather Force* by John Gribbin, Hamlyn, London and New York, 1979 **2. *Causes of Climate*** by J G Lockwood, Edward Arnold London, 1979 **3.** What's happening to our climate? *National Geographic*, November (1976) 576. **4.** Climatology Supplement, ***Nature* 276** (1977) 327 **5.** The carbon dioxide question, *Scientific American*, January (1978) 34.



Pity it s held up so long We can blast off tomorrow if only we count a man to count-down!



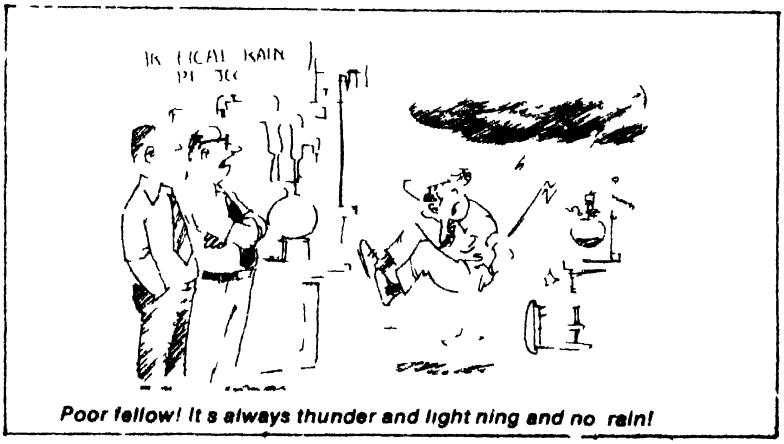
Is this the breakthrough in karate you were so keen on showing me?

This World of Science!

by R K Laxman



My son works there He keeps sending up those anti-pollution messages all the time



Poor fellow! It s always thunder and lightning and no rain!

...and of Scientists!

JOHN NEUMANN (1903-1953), who laid down the principles for the construction of giant computers, also developed a new branch of mathematics called game theory, the principles of which can be applied not only to simple games but also to more complicated matters like business and war He told J Bronowski

Chess is not a game It is a well-defined form of computation In theory there must be a solution, a right procedure in any position Real life consists of little tactics of deception, of asking yourself what is the other man going to do "

He elaborated these ideas into a chapter, Poker and Bluffing substantiated by equations in his book *Theory of Game and Economic Behaviour*

***

BENJAMIN THOMPSON better known as Count Rumford, while in the service of the Elector of Bavaria, used to get over 2,500 laymen arrested in a day and put to work in a factory specially set up for them He explained this by saying, To make vicious and abandoned people happy it has generally been supposed necessary to make them virtuous first Why not reverse this order? Why not make them happy and then virtuous?

Count Rumford originally an American who owing to his sympathy for the English during the Revolutionary War found himself virtually in exile from his country after the War cast grave doubt on the accepted idea that heat was a fluid called caloric He was the first to attempt to work out the mechanical equivalent of heat

S N MUNSHI

***



IN his address to the American Chemical Society Joel Hildebrand a former President of the Society told of his experience as a college student at the turn of the century When I became a freshman at the University of Pennsylvania, the lectures on chemistry to which I listened afforded opportunities to apply my developing confidence in reasoned experimentation For example, the lecturer defined chemistry as the science that deals with deep-seated, permanent changes in matter Physics, by inference, deals with temporary superficial changes He illustrated physics by using an electromagnet to pick up a nail, which dropped off when the circuit was broken I longed to ask whether if the core of the magnet were made of steel and the nail had remained stuck to it, it would illustrate chemistry But I did not, because the lecturer was an authority"

C D 'S.

When food bowls turn into fuel farms

Lester R Brown

The competing uses of agricultural land for food or for fuel are bound to cause some severe strains on world food supplies

AS THE eighties begin world oil production is levelling off Along with this bleak production prospect, there is a growing uncertainty of supply A world price of oil that climbs continually, with no apparent limit in sight, signals a fundamental change in the outlook for liquid fuels

This changing prospect has triggered an intense international search for alternative liquid fuels Prominent among these are liquefied coal oil from tar sands and oil shale and alcohol that can be produced from plant materials Although there are vast reserves of coal tar sands and oil shale the development of liquid fuel from these unconventional sources is handicapped by lack of experience Even under the best of circumstances these are unlikely to become major sources of liquid fuel before the early nineties

It is against this backdrop that many countries are turning to alcohol distilled from farm commodities as a source of fuel for automobiles An alcohol fuel industry has several attractions Automobile engines can readily burn a gasoline alcohol mixture containing up to 10 per cent alcohol without any adjustment The commercial production of alcohol for industrial purposes is already a well established industry and the technology for converting plant materials into alcohol is widely dispersed throughout the world Distilleries can be built within 6 to 24 months

This combination of advantages has led several countries to launch agriculturally based alcohol fuel programmes Both Brazil and the United States have announced major programmes to convert agricultural commodities into alcohol Several other food exporting countries – such as Australia New Zealand and South Africa – are actively considering the conversion of crops into alcohol for fuel on a commercial scale

If more and more oil refineries are replaced by alcohol distilleries, the world agricultural economy will be transformed With the introduction of fuel crops, the possibility exists for the first time of a major shift of food production capacity to non-food purposes The potential demand is virtually limitless, even if the entire world grain crop were converted to alcohol, it would not provide enough fuel to operate the current world automobile fleet

The attractions of an agriculturally-based alcohol fuel industry notwithstanding there are many problems to be considered The expansion of energy crops will greatly intensify pressures on the earth's cropland—pressures that are already excessive in many parts of the world and that have led to extensive erosion and soil deterioration Even without the diversion of agricultural production capacity to energy crops



"Can governments encourage the production of alcohol fuel from agricultural crops without inadvertently launching an industry that competes directly with food production?"

efforts to expand world food production have been losing momentum for nearly a decade And while the rate of world population growth did slow slightly during the seventies, from 1 9 per cent in 1970 to 1 7 per cent or less in 1979, the absolute increase in world population continues at around 70 million per year, steadily adding to the number of people to be fed

The demand by motorists for fuel from energy crops represents a major new variable in the food-population equation The stage is set for direct competition between the affluent minority, who own the world's 315 million automobiles, and the poorest segments of humanity for whom getting enough food to stay alive is already a struggle As the price of gasoline rises so, too, will the profitability of energy crops Over time, an expanding agricultural fuels market will mean that more and more farmers will have a choice of producing food for people or fuel for automobiles They are likely to produce whichever is more profitable

Among the countries that either are producing ethanol for fuel already or are actively considering it are Brazil, the United States South Africa, New Zealand and Australia Within this group, Brazil has moved rapidly to develop and implement a national alcohol fuel programme, based principally on sugarcane Brazil relies on imports for 85 per cent of its oil yet the country has based its vast transportation system on highways and motor vehicle transport By mid-1979, Brazil was spending an estimated $6 5 billion annually on oil, importing nearly one million barrels a day

Brazil's alcohol fuel programme was launched in 1975 After the Iranian revolution and the associated increases in the world price of oil during early 1979, the government accelerated its programme, Between 1975 and 1985, an estimated $5 billion will pass through the National Alcohol Programme as subsidies for production and consumption of alcohol fuel

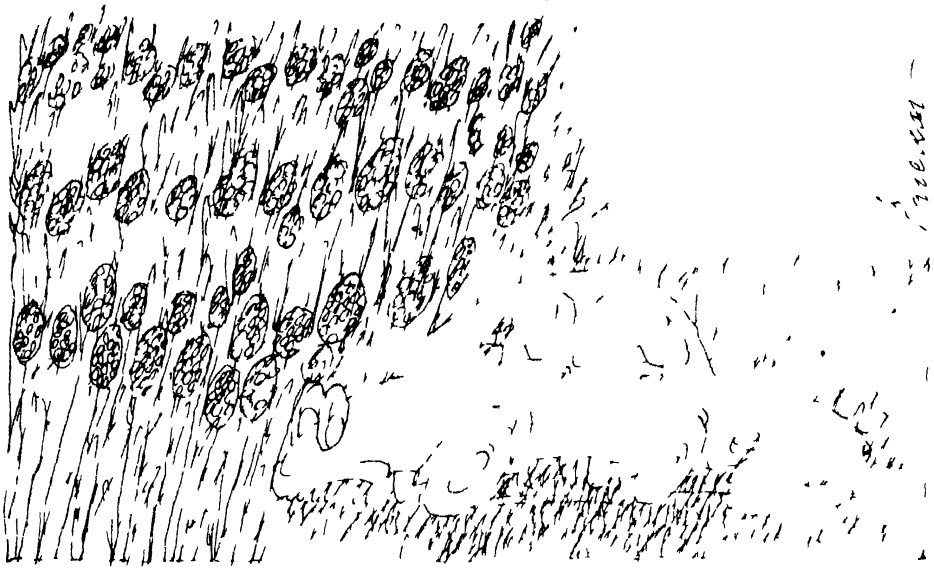
In 1979, alcohol accounted for an estimated 14 per cent (three billion litres) of Brazil's automotive fuel consumption, most of it as gasohol, but in

1980, when it is expected to constitute 20 per cent of the total, some of it will be used in new cars designed to run exclusively on alcohol Industry sources within Brazil believe they can produce 20 billion litres of alcohol for fuel by 1985, enough to provide 60 to 70 per cent of the fuel requirements of the projected automobile fleet of 12 million vehicles Government officials are less optimistic They project a production of just under 11 billion litres of alcohol fuel by 1985

adaptation of manioc as an alcohol feedstock, because manioc can be produced by smallholders on the marginal land most common in the least developed regions of the country

US efforts

American enthusiasm for alcohol fuels has increased in direct proportion to the rise in gasoline prices The first major boost for the alcohol fuel programme came with the Energy Act of 1978, which removed



"The demand by motorists for fuel from energy crops represents a major new variable in the food-population equation. The stage is set for direct competition between the affluent minority, who own the world's 315 million automobiles, and the poorest segments of humanity for who getting enough food to stay alive is already a struggle."

The ambitious Brazilian alcohol fuel programme is based largely on sugarcane, the most efficient of all energy crops Sugarcane currently yields 1,760 litres of alcohol per acre nearly 65 per cent more than corn, the major distillery feedstock in the United States Although only 2 per cent of Brazil's total land area would need to be planted to sugarcane to achieve the goal of automotive fuel self-sufficiency, this would amount to half of the total land area currently planted to crops

Although the overriding objective of the Brazilian alcohol fuel programme is to rid the country of dependence on imported oil, there are other goals The government hopes that by creating jobs for presently unemployed rural workers on land that is now unused, the programme will help stem the tide of urban migration, improve the country's skewed income distribution, and foster more balanced development throughout the country But the key to achieving these goals may lie in the successful

the federal gasoline tax of four cents on every gallon of gasohol containing alcohol obtained from non petroleum sources In January 1980, the US alcohol fuel programme received a second big boost when the White House announced major new goals for both 1981 and the mid eighties The aim by the end of 1981 is to produce 2275 million litres of ethanol for fuel, six times the amount produced in 1979, and for the mid-eighties the goal is 9 1 billion litres

To produce 2275 million litres of ethanol for fuel by the end of 1981 is an obviously ambitious goal, considering it takes nearly two years to build a large alcohol distillery It requires roughly 200 million bushels of corn, the output from two million acres at current US yields In tonnage terms, this amounts to five million tons of corn, or about five per cent of the projected US grain exports of nearly 100 million tons in 1980 The mid-eighties ethanol production goal would require about 20 million tons of corn—one-fifth of the current exportable grain surplus. All told, it is expected that between $8 5 billion and $13 billion will be committed to encouraging the alcohol fuel industry

In addition to the programme announced by the White House, the Department of Energy is already looking into the use of sweet sorghum to produce ethanol Over the long term, the Energy Department believes that sweet sorghum could become the dominant energy crop in the USA By the end of the century, according to their analysts, 14 million acres of cropland could be planted to sweet sorghum that would yield 38 billion litres of ethanol per year

A more modest source of domestically produced ethanol in the USA is that produced from agricultural waste The Department of Energy estimates that it is now economically feasible to convert four-fifths of the country's cheese whey, citrus wastes, and other food processing wastes into alcohol If the distilleries were in place, these sources could yield close to 2275 million litres of ethanol in 1980, increasing to 2900 million litres by the end of the century

Although alcohol can become a significant source of liquid fuel in the USA it could not become a dominant fuel source for automobiles if it is produced from grain Converting the entire US grain harvest into alcohol would not yield more than 136 billion litres or 30 per cent of US annual gasoline consumption While Brazil can consider producing automobiles that burn alcohol exclusively, in the US ethanol will probably be limited to its role as an octane booster when mixed with gasoline in small amounts

Commercial interests

Another country that has examined carefully the potential for producing liquid automotive fuels from agricultural commodities is New Zealand The most likely feedstock for alcohol distilleries there would be a type of sugar beet or fodder beet New Zealand would need to at least double the current area under crops if it were to become fuel self-sufficient without taking land that is already being used to produce food

In Australia, which ranks third behind the US and Canada as an exporter of cereals, a strong commercial interest in liquid fuels is beginning to emerge from the private sector Australia's AMPOL Petroleum Limited and Bio-Technology Australia Proprietary Limited have calculated that within five years Australia could be producing 15 to 20 per cent of its fuel for motor vehicles in the form of alcohol distilled from wheat This would require roughly as much wheat as Australia currently produces.

South Africa, which currently leads the world in the production of liquefied fuels from coal, also has a large project to produce alcohol from crops. It is planning to use both cassava, which is a dietary staple in many parts of Africa, and sugarcane as raw materials for the production of alcohol. Current plans call for converting the Makatini Flats in northern Zululand, a semi-arid plain with sparse vegetation, into cassava plantations. South Africans talk of converting this arid plain into an oil field. It is also being promoted by the South African government as a way of encouraging rural development. To the extent that cassava can be grown in areas that were not producing anything of agricultural value, and with resources that would not otherwise be used to produce food, these new 'oil fields' will not compete with food crops.

The sugarcane part of the South African alcohol fuel project, however, would compete directly with food crops. Indeed, in order to encourage greater sugarcane production, the government is guaranteeing water supplies to farmers who will grow sugarcane explicitly for the production of alcohol. Under this arrangement, sugarcane grown as an energy crop would in all likelihood divert both land and water from food production.

South Africa is also the site of another innovative experiment in liquid fuels. Sunflower seed oil apparently has worked well in the first 100 hours of trials in a diesel engine. If this should prove successful, it is estimated that corn farmers could grow enough sunflowers on just 10 percent of their land to provide all the fuel for their tractors.

Although the national alcohol fuel programmes sketched out above are the most advanced, other countries are exploring the potential. Some are looking at agricultural by-products, while others are considering the direct conversion of farm commodities into alcohol. Kenya is building an alcohol distillery that will use the molasses by-product of its sugar mills. Thailand, on the other hand, is interested in an agricultural fuel industry partly as a way to stabilise the prices of its agricultural commodities. It is seeking bids for the construction of distilleries that could be adapted to whatever crop was in greatest surplus – cassava, maize, sugarcane or molasses.

The changing pattern of world grain trade

Region	1934-38	1948-52	1960	1970	1978
	(million metric tons)				
North America	+ 5	+ 23	+ 39	+ 56	+ 104
Latin America	+ 9	+ 1	0	+ 4	0
Western Europe	-24	-22	-25	-30	-21
Eastern Europe and USSR	+ 5	0	0	0	- 27
Africa	+ 1	0	2	5	- 12
Asia	+ 2	- 6	17	37	- 53
Australia and New Zealand	+ 3	+ 3	+ 6	+ 12	+ 14

Plus sign indicates net exports, minus sign net imports

Source: Food and Agriculture Organisation, US Department of Agriculture and author's estimates

Food production slows down

The numerous national programmes to divert agricultural resources to the production of fuel crops come at a time when efforts to expand world food output are losing momentum. Between 1950 and 1970, per capita grain production worldwide increased by some 40 percent, leading to substantial improvements in nutrition not only in many rich countries but in much of the Third World as well. Since 1971, however, growth in world food output has failed scarcely to keep pace with population growth. The failure of world grain output to match the increase in both population and incomes led to rising food prices during the 1970s.

As food production has slowed, global food insecurity has increased. Throughout the sixties and early seventies, the world had two major reserves: free of the burdensome stocks of grain and vast areas of cropland idled under US farm programmes. Together these provided a period of unprecedented stability in world food supplies and prices. But since 1972 most of the idled farmland has been returned to production. Even with this addition, however, the production of food in some years has not matched the growth in world demand. As the eighties begin, the world has only one food reserve left – its stocks of grain.

In addition to the decline in reserves, production has become more erratic. Efforts to double food output over the last three decades have pushed agriculture into areas of marginal rainfall and onto marginal soil. The results of farming where rainfall is unreliable is dramatically evident in the Soviet Union, where a crop failure every third year or so is commonplace in the virgin lands the new areas brought under the plough during the 1950s. The 1975 Soviet decision to offset a crop shortfall through imports had an extraordinarily destabilising effect on the world food economy, leading to wide fluctuations in world grain prices.

A further source of instability has been the growing dependence of the entire world on one region, North America, for its food supplies. Both the US and Canada are affected by the same climatic cycles. As a crop failure in one is likely to be associated with a failure in the other, heavy reliance on the region is even riskier than it at first seems.

World demand for grain has been expanding by some 50 million tons per year over the past decade. Of this total, the bulk is needed to cover the increase in human numbers, leaving little to upgrade diets.

Other prominent reasons for the slowing growth in world food output are the continuing conversion of prime cropland to non-farm uses, the excessive erosion of soil on at least one-fifth of the world's cropland, the rising cost of energy for farmers, and the diminishing returns on additional applications of fertiliser in agriculturally advanced countries.

All the forces that have contributed to the loss of momentum on the food front during the seventies seem certain to intensify in the eighties. Even without the competition from energy crops, the world will be hard pressed to avoid a decline in per capita food production during the decade if the projected increases in population materialise. It is against this backdrop that the emergence of national energy crops initiatives must be evaluated.

The potential claim of automobiles

"The numerous national programmes to divert agricultural resources to the production of fuel crops come at a time when efforts to expand world food output are losing momentum. Since 1971, the growth in world food output has slowed, scarcely keeping pace with population growth. All the forces that have contributed to this loss of momentum, seem certain to intensify in the eighties."

on future food-producing resources can best be illustrated by comparing the area of cropland required to feed a person with that needed to run an automobile on alcohol. Per capita grain consumption in developing countries averages roughly 181 kg annually, or just about half a kg per day. In the most affluent countries where diets are rich in livestock products, each person consumes an average of 726 kg of grain, including the amount eaten directly in cereal products and that consumed indirectly in the form of meat, milk, and eggs. At average world yields of grain, satisfying the annual food needs of a typical consumer in the Third World requires roughly one-quarter of an acre of cropland, whereas someone living in a more affluent country requires nearly an acre.

An automobile run on ethanol requires far more grain than a person does. Running a typical American automobile entirely on alcohol would require almost eight acres, given the average world grain yield, while a European car would require less than four. Land requirements vary, of course, with grain yields. If wheat grown in low rainfall areas such as Australia or the US Great Plains is used as the alcohol feed-stock, then land requirements are far higher than if corn grown in the US Corn Belt is used. In Brazil, where cars are smaller and where sugarcane with its higher alcohol yield per acre is used, two acres of land might support an automobile.

Social implications

As for gasohol, providing fuel for the typical US car would require 662.24 kg of grain in order to reach the 10 per cent mix of ethanol with gasoline. This is slightly less grain than someone in an affluent country consumes directly and indirectly as food. Nevertheless, the cropland requirements of an American car owner who switches to gasohol would nearly double, rising from 0.9 to 1.7 acres.

These calculations on the amount of cropland needed to run an automobile on alcohol or gasohol are in one important sense understated or they do not take into account the liquid fuel used in the production of alcohol. If the petroleum used to produce one acre of grain or sugarcane is deducted from the liquid fuel that acre produces, it is clear that a substantially larger area of cropland is required to run an automobile on ethanol.

The social and political ramifications of a massive production of energy crops will probably surface first in Brazil, the only country that is committed to running its entire fleet of cars on alcohol. When President Figueiredo signed a protocol in September 1979 with the National Automakers Association confirming the intention of producing 250,000 automobiles in 1980 that would run entirely on alcohol, he was in effect claiming some 200,000 hectares of cropland for sugarcane.

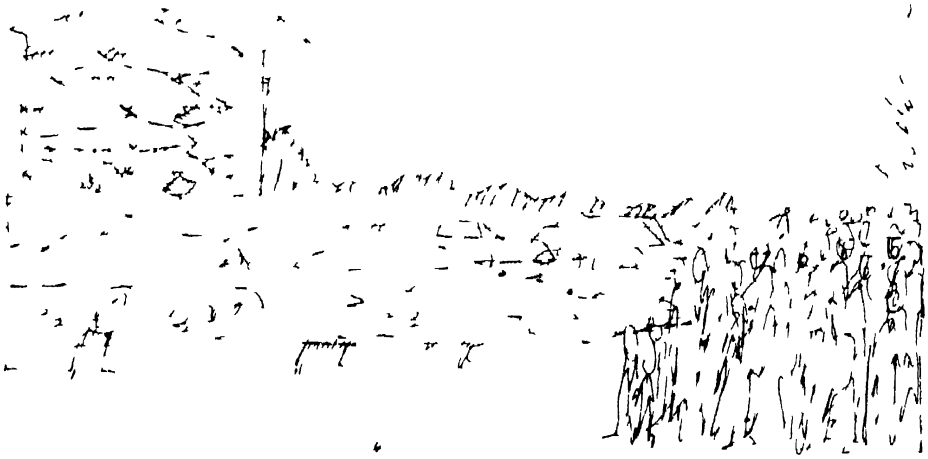
Glaring disparities

Brazil has one of the world's most widely skewed income distribution patterns, with a ratio of 36 to 1 between the average income of the richest one-fifth of its population and that of the poorest one-fifth. The population of 121 million Brazilians includes some of the world's wealthiest individuals as well as the largest segment of severely impoverished people outside Asia. A 1975 study showed that only one-third of all Brazilians were eating a sufficiently nourishing diet, measured against minimum requirements outlined by the UN Food and Agriculture Organisation and the World Health Organisation. Evidence of malnutrition was found in the country's high infant mortality rate and in the fact that less than half the children under the age of 18 at the time had reached the normal weight for their age.

The decision to turn to energy crops to fuel the country's rapidly growing fleet of automobiles is certain to drive food prices upward, thus leading to more severe malnutrition among the poor. In effect, the more affluent one-fifth of the population who own most of the automobiles will dramatically increase their individual claims on cropland from roughly one to at least three acres, further squeezing the millions who are at the low end of the Brazilian economic ladder.

Brazilian officials claim that the production of energy crops will be in addition to rather than in competition with that of food crops. But energy crops compete not only for land but also for agricultural investment capital, water, fertiliser, farm management skills, farm-to-market roads, agricultural credit, and technical advisory services. In the absence of a planned economy where all agricultural inputs are carefully controlled and clearly tagged for the production of either food or energy, it would seem to be impossible to launch a major energy crops programme without siphoning resources away from food production. The assumption that energy crops will not compete with food crops may be both naive and politically risky. The upward pressure on food prices that will be generated by the rapid expansion of energy crop production could put a severe strain on the Brazilian social fabric and political system.

The immediate consequence of the Brazilian energy crops programme may be more internal than external, but the more recently launched effort in the US has broader ramifications. If US cropland is shifted to energy crops on a massive scale, it will be at the expense of the exportable surplus of grain. Over the past generation the entire world has come to depend heavily on North American grain exports. Since World War II scores of countries have become food importers, yet not one new country has emerged as a significant cereal



"The assumption that energy crops will not compete with food crops may be both naive and politically risky. The upward pressure on food prices that will be generated by the rapid expansion of energy crop production could put a severe strain on the Brazilian social fabric and political system."

exporter As more and more alcohol fuel distilleries are built in the US in order to meet the official goal of producing two billion gallons of ethanol by the mid-eighties, the exportable surplus of grain will be reduced accordingly In addition to the traditional buyers in the North American grain market the flour millers the feedlot operators, and the grain-importing countries—there will be a fourth, potentially large, group the distillers

Exactly how high the price of grain could eventually be driven by distillers is difficult to say Obviously the higher gasoline prices go the more distillers can afford to pay per bushel of grain Experience in other countries, such as France, East Germany Greece Singapore and Turkey indicates that motorists can and will pay $3 or more per gallon There is little reason to doubt that American motorists with their much greater purchasing power would not ultimately pay as much

When gasoline reaches two dollars per gallon US distillers could probably afford to pay five dollars a bushel for corn about double the March 1980 price If the price of gasoline should reach three dollars per gallon distillers might be able to pay close to six dollars per bushel for corn without subsidies and credits If the phased decontrol of oil prices in the US proceeds on schedule and oil prices move to the world market level by the end of 1981 gasoline prices will rise accordingly Under these circumstances US distillers will be in a strong position to bid for a growing share of the US grain harvest

Attractions of alcohol fuel

The attractions of alcohol fuel are clear For countries buffeted by soaring oil prices and possibly supply disruptions the prospect of an easily available substitute for some of the imported oil is an inviting one Although the world's oil reserves are concentrated in a handful of countries the potential for producing energy crops is as widely diffused as agriculture itself

There are also some solid environmental reasons to support alcohol fuel It is clean burning and can substitute for lead as an octane booster In contrast to the burning of petroleum, liquefied coal, or other automotive fuels of fossil origin, alcohol produced from plant materials does not increase the amount of carbon dioxide in the atmosphere, unless of course it leads to an overall reduction in the plant material in the world In addition, it is a renewable resource, a potentially important component in any effort to create a sustainable economy.



constituency Distillers have an obvious interest, one that is certain to expand as the number of distilleries increases For farmers, an automotive fuel industry based on agricultural commodities has a strong economic appeal They see alcohol fuel as a way of expanding the markets and boosting the prices for their products

Alcohol fuel has a powerful political appeal to motorists who bear the brunt of rising gasoline prices and who feel vulnerable to possible oil supply disruptions The political influence of automobile owners in the countries at intermediate stages of economic development such as Brazil should not be underestimated Those who own cars in these societies also comprise the urban elite who dominate the political power structure As governments in the Third World consider diverting cropland to the production of fuel crops rather than food those who own automobiles may have a disproportionately large say in the matter

These attractions of agriculturally derived alcohol fuel must be set against its potential impact on world food prices By far the most serious environmental impact of energy crops will be the additional pressures they put on cropland The doubling of world food output over the past generation has led to the adoption of cropping practices that are resulting in excessive soil erosion and undermining its productivity With the demand for food projected to double again over the next generation, it will be difficult to lighten the demands on soils and to arrest their long-term deterioration If in addition vast areas are planted to energy crops the problem will become even more unmanageable

For the world's affluent, rises in food prices may lead to belt-tightening, but for the several hundred million who are already spending most of their meagre incomes on food, continually rising food prices will further narrow the margin of survival"

Economically energy crops production and alcohol distillation are far more labour intensive than oil production and refining And because distilleries are dispersed throughout the countryside close to their feedstock supplies they generate industrial as well as on farm employment in rural areas where unemployment is usually highest Jobs created in the countryside of the Third World can also help slow the migration to the mushrooming squatter settlements that surround so many cities

One inevitable consequence of energy crops programmes will be a reassessment of national population policies As food-exporting countries particularly the US attempt to increase automotive fuel self sufficiency by converting exportable grain supplies into fuel, food-deficit countries will be forced to become more self-sufficient In the scores of countries where rapid population growth has led to a greater dependence on US food exports, the need to accelerate population education and family planning programmes will be brought into sharper focus

Programmes to produce energy crops domestically have found a ready

As the number of distilleries multiplies, the production of energy crops will expand until an economic equilibrium is reached between the price of agricultural commodities used as distillery feedstock and the price of those used for food or feed In the absence of any governmental limitations on the conversion of agricultural commodities into fuel the price of oil could eventually set the price of food

The expanding production of fuel crops could underline the vast disparities in income within and among societies as perhaps nothing else has ever done Until recently the average per capita claim on the earth's food-

Implications for Indian agriculture

THE relationship between food and fuel is generally not perceived. At best, a layman may say that one needs fuel to cook food or a man needs food to survive while the machine will not work without fuel. At present, the main source of fuel for most of the mobile machines, including those used on the farm to produce food, is petroleum products obtained from crude oil. There are exceptions, of course—the steam locomotive fired by coal, electric trains, tram cars and trolley buses operating on power obtained from other energy sources like hydro, coal or nuclear. The electric car operating on chargeable batteries or on hydrogen fuel is not fully commercial and has its own limitations. Thus there is a great demand for liquid fuels to run the mobile machines which include 315 million automobiles used as personal transport by the affluent citizens of the world. A personal transport still remains the cherished dream of millions in the Third World.

The realisation that oil reserves are not infinite, are controlled by a few nations, supplies can be disrupted under political pressure or in the event of a war and, above all, the rapidly increasing crude oil prices have led to the intensification of the search for alternative, renewable sources of liquid fuels. Alcohol obtained from different agricultural products, either crops or their residues, comes closest to satisfy these requirements. The technology for the production of ethanol is well established and is relatively simple. It is obtained on fermentation of plant materials containing mainly carbohydrates like sugars, starch and even cellulose. Several alternative farm products can be used, all of which are renewable and can be grown in areas wherever economic crop production is feasible. This has led several nations to support programmes for the production of alcohol from local crops and crop residues.

In his thought-provoking article, Dr. Lester R. Brown, of the Worldwatch Institute, has analysed ethanol production from agricultural crops or energy crops as he terms them (sugarcane, cassava, sweet sorghum and cereals) from various angles of technology, economics, socio-political effects and its impact on food supplies and prices. This paper is of great significance for most oil-importing countries, particularly those in the Third World with low export earnings and those which also depend on food imports. Fortunately, in India, at present, we are in a slightly better situation with regard to foodgrains production. However, in India and elsewhere too, the increased foodgrain production in recent years is heavily dependent upon imported fossil fuel inputs which may be in the form of fertilisers, diesel and pesticides. And in many parts of the country, there were acute shortages of diesel to operate farm machinery and irrigation pumps during the last *rabi* season. Here, we will briefly examine the impact of largescale alcohol production based on agricultural crops in India.

Brazil has the most ambitious programme for alcohol production from fuel crops, aiming, eventually, to be self-sufficient in fuel. The Brazilian programme is mainly based on sugarcane which is the most efficient plant for alcohol production. In order to achieve self-sufficiency in alcohol production, sugarcane will have to be grown on two per cent of Brazil's total land area or roughly 17 million hectares which is more than the combined area under sugarcane in 65 other sugarcane growing countries. Of course, countries like Brazil with a large area (8,512,000 square km) and a low population density (13 per square km) can afford to divert such large areas for energy crops. This certainly would not be possible in densely populated countries in South-east Asia where already the agricultural land is under pressure to produce more food and farming competes with various other non-agricultural land uses. Though Brazil has been used as a case study, similar situations with minor variations are likely to be encountered in most developing countries.

Agriculture in India accounts for 42 per cent of the net domestic product. Though the net area sown is over 143 million hectares, production per unit area is low compared to other, agriculturally advanced countries. Since independence, the country had been importing foodgrains which reached a peak of over 10 million tons in 1966. Domestic foodgrain production had steadily increased from 55 million tons in 1949-50 to nearly 126 million tons in 1977-78. This is a commendable achievement, but in the same period population increased from 361 million to 660 million. There has been no foodgrain import since 1978 and the country now has a grain reserve of 20 million tons.

The increase in foodgrain production was mainly due to the use of improved varieties of seeds, higher inputs of water, fertilisers and pesticides, besides some overall improvements in management. However, all these inputs also have an energy cost: at present, they heavily depend upon imported liquid fuels for their manufacture, transport, preparations, etc. Traditional agriculture, with its low productivity, was based entirely on renewable energy sources. Animals, deriving their energy from the sun through plant products as feed, were used for all farm operations and transportation. They were also the source of farmyard manure which maintained soil productivity. Even today, in many villages the only fossil fuel used is kerosene in hurricane lanterns for light. A similar situation existed in the US during the 1920s when animal power was extensively used on the farm and agriculture produced not only food but also the energy required to produce food.

With this background of Indian agriculture, one could examine the implications of diverting agricultural production for manufacturing alcohol both within the country and in other food-exporting nations. Without going into the details, we have briefly considered the two extreme possibilities, one optimistic, as all of us would like to see it, and the other pessimistic.

Let us look at the brighter side first. Of course, in any discussion pertaining to the food-population equation, the most important variable relevant to the Indian situation is the increasing population growth which, in any case, should be arrested to balance this equation.

India has a large cropland area with 22.2 per cent of it under irrigation. Climatic conditions permit cropping throughout the year in most parts if irrigation is available. Still, the irrigation potential is not fully utilised and average yields per unit area are about half of what are obtained in better managed farms. The major constraints in areas of assured irrigation are the inputs, economic resources and managerial skills of the farmers to adopt the available improved technology. This has been referred to as resource-cum-extension-cum-management gap. In dryland agriculture, production will always depend upon the vagaries of the monsoon, but appropriate crops and technology can certainly improve the overall production potential considerably.

now published (*Nature* **285**, 456) the first

Crop residues

Industrial alcohol, using molasses, a by-product of the sugar industry, is already produced at several places in the country. There is hardly any scope of diverting crop residues for ethanol production as they are used either as cattle feed or fuel. Besides, they are bulky and, in any industrial production, the energy requirements and cost of transportation will have to be considered.

Sugarcane and cassava (SCIENCE TODAY, January 1980, p 28) are the two main crops in the country that can be used for alcohol production. Sweet sorghum appears to have a great potential as an energy crop. Though sorghum is widely grown in India, sweet sorghum is not commercially cultivated. A lot of research may need to be done for intensive breeding and agronomic improve-

ment of sweet sorghum. It may be an energy crop well suited to Indian conditions. In fact, Dr A.D Kurve, of the Nimbkar Agricultural Research Institute in Phaltan, Maharashtra, has been advocating sweet sorghum as an alternative to sugarcane for sugar production in certain parts of the country

We are not likely to have surplus cereals or grains for making alcohol in the near future The large stocks in reserve at the moment are, in fact, not a real surplus, but is due to the low purchasing capacity of the people who starve or remain undernourished With rise in population or increase in the purchasing power, the demand for foodgrains would increase And there is no additional land available that can be brought under cultivation without clearing the already low areas under forests Hence, increasing production per unit area is the only alternative available (SCIENCE TODAY November 1979, p 29)

Experiences reported in Dr Brown's paper indicate that farm machinery like tractors and pumps can be operated on alcohol or vegetable oils This opens up the possibilities of mechanised farming based on renewable energy sources A farmer will not have to depend on imported diesel to operate a tractor or an irrigation pump He can get all his fuel requirements from the local distillery or oil mill Similarly dependence on fertilisers and synthetic pesticides can be reduced by including nitrogen-fixing grain legumes or blue-green algae in crop rotations and developing natural plant products for pest control Biogas and solar energy can also provide day-to day domestic and community needs in the villages Indian agriculture can thus provide both food and fuel and can help in reducing the dependence on imported oil Excess food production can also help in paying for the imported oil Many oil-exporting countries are so much short of water that economic food production is not feasible and hence they have to depend on imported food

On the other hand, diversion of croplands for energy crops could cut foodgrain production, reducing the amount of grain reserves A few years of drought, as in the past, could then force us to buy foodgrains in the international market which certainly would be beyond the purchasing capacity of the poor The country's limited financial resources certainly would not permit import of both food and fuel

C. R. BHATIA
R. MITRA

Dr. Bhatia and Dr Mitra are with the Biology and Agriculture Division of the Bhabha Atomic Research Centre, Bombay. They are currently studying the bioenergetics of crop production



producing resources has not usually varied from the richest to the poorest countries by more than a factor of five to one With the advent of energy crops, however the ratio could increase dramatically The social consequences of turning to energy crops raise doubts about whether industrial societies should continue to rely so heavily on cars and whether developing countries should attempt to make the automobile the centre piece of their transportation systems

Where the goal is to reduce oil imports alternative measures to achieve the same end deserve to be examined Relatively modest improvements in public transportation for example could markedly reduce dependence on automobiles in urban areas Within the US such modest measures as the banning of automatic transmissions in new automobiles except those for the physically handicapped would save more fuel by the mid eighties than the ambitious alcohol fuel programme is expected to yield Such a step would obviously involve some sacrifice on the part of those preferring automatic transmissions but this should be weighed against the social costs of diverting food production resources to energy crops

Conflicting programmes

The question is not whether there should be an alcohol fuel industry Clearly there are many possibilities for converting agricultural wastes and other sources of plant materials into automotive fuels that need to be urgently pursued Over the longer term, a carefully designed alcohol fuel programme based on forest products could become an important source of fuel, one that would not compete with food production Liquid fuel from plants, whether in the form of alcohol or as direct hydrocarbon extracts is an energy source that needs to be aggressively exploited everywhere At issue is whether governments can encourage the production of alcohol fuel without inadvertently launching an industry that competes directly with food production

If the potentially adverse effects of current programmes to produce fuel from crops are to be minimised, several steps must be taken immediately The governments launching these programmes need to warn food-deficit countries of the potential reduction in exportable food surpluses so that they can adjust their agricultural and population policies accordingly Secondly the move toward energy crops reinforces the need for an internationally coordinated effort to arrest the excessive erosion of topsoil Without such an initiative the widespread planting of energy crops will accelerate the deterioration of the world's cropland base Where agricultural fuel programmes are launched, priority in the use of fuel should be given to tractors and other farm uses over automobiles And finally a global food-price monitoring system that would be sensitive to the impact of alcohol fuel programmes is needed Such a system is essential if political leaders are to assess the worldwide impact of national energy crops initiatives on food prices

Within the food exporting countries the short-run attractions of energy crops are undeniable Whether the longer-term political effects will be as attractive is less clear In a world that no longer has any excess food production capacity, the decision to channel foodstuffs into the production of automotive fuel will inevitably drive food prices upward For the world's affluent, such rises in food prices may lead to belt-tightening but for the several hundred million who are already spending most of their meagre incomes on food, continually rising food prices will further narrow the thin margin of survival

Dr Brown is President of the Worldwatch Institute Washington USA which studies global problems This article has been abstracted from his paper prepared for the Institute

Vehicle shapes and fuel bills

M.M. Sivaramakrishnan

Fuel cost can be substantially cut down by streamlining vehicle shapes

ON THE HIGHWAYS, trucks carrying the legend Private Carrier or Public Carrier or some other name on top is a familiar sight. Not many realise that this rectangular plank of wood or metal, right in the front, really serves no useful purpose. It is, in fact, a drag on the movement of the truck. Do you know that a truck running at 80 kilometres per hour needs about five horse-power just to overcome this aerodynamic drag? And on a 1600-km run from Bombay to Delhi, this means 20 litres of extra diesel.

The legend plate, of course, is only a minor source of such drag. And trucks are not the only vehicles paying such penalties in terms of fuel for bad designs. From aerodynamic considerations, there are far too many vehicles on our roads (and also our railways) which are poorly and inefficiently shaped. Together, they add up to a heavy and unnecessary excess of fuel consumption.

Consider, for instance, a truck with a cross-sectional area of about 15 square metres, an optimistically low fuel consumption of 7×10^{-8} kg per watt-second and a mechanical efficiency of 0.85. At a speed of 80 kmph, the aerodynamic drag of such a vehicle could account for nearly 220 litres of diesel per 1000 km (125 litres at 60 kmph). Even if we consider a medium sized transport fleet of just 100 trucks, running 300 km per day at an average speed of 60 kmph, a mere 10 per cent drag reduction could save nearly a million litres of diesel a year. This is possible with only some minor modifications in the design of external and peripheral features of the present-day trucks.

Transport has been the heaviest casualty of rising fuel costs, and taking immediate steps to conserve and save fuel is becoming more and more important. An immediate measure would be to concentrate research on finding ways of saving fuel consumption in transportation. There are essentially three ways of doing it. One is by improving the efficiency of combustion and energy conversion. The second is to use some other mode of transport or design which does not use this type of fuel as the source of power. And the third would be to reduce the resistance to motion.

The first two depend on the particular characteristics of the fuels. The third, however, is independent of the fuel used. It would, therefore, be beneficial to study the various aspects of resistance that a vehicle in motion has to face, and the techniques for reducing it. And that is where aerodynamics enters the design of ground vehicles.

In Detroit, USA, where the fuel pinch is being felt most sharply, a large wind-tunnel has been constructed already for the exclusive testing of the aerodynamic design of automobiles. As the power and fuel situation in India is no less serious, even some very simple design modifications could go a long way towards cutting fuel and power consumption. But first, let us take a brief look at some of the aerodynamic drag mechanisms associated with ground vehicles, such as cars, trucks and trains and consider the available techniques for improving their aerodynamic design

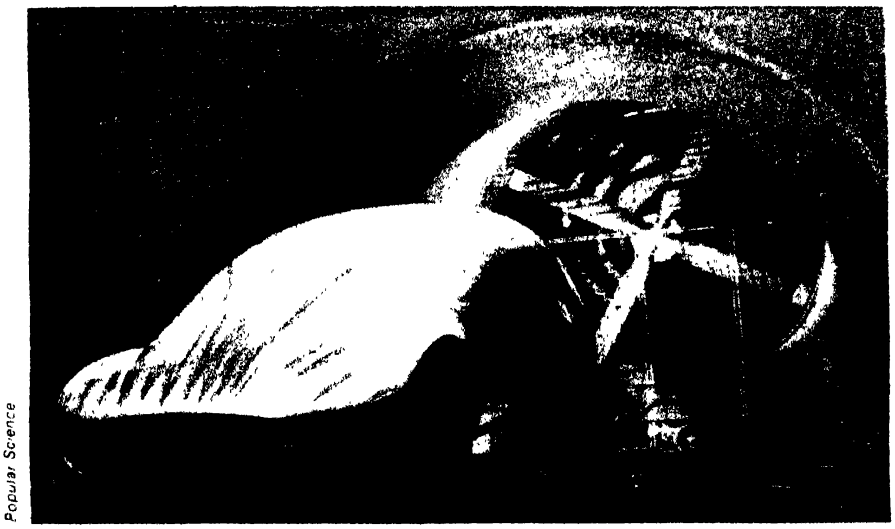
What is aerodynamic drag?

Aerodynamic drag is the resistance offered by air to the movement of any body through it. A bicyclist puffing with all his might against a cross-wind, a spinning top slowing down and toppling, a feather floating in the wind—they all experience aerodynamic drag. Some very simple experiments can bring out its characteristics.

If one places a hand outside the window of a car (or train, or any other vehicle) which is moving at a low speed (up to about 20 kmph) in still air, one feels little resistance. But at high speeds, of say 100 kmph, if the hand is held outside, with the palm vertical, the wind force trying to push the hand back would be quite appreciable. If one keeps one's head out at such speeds one is likely to develop a pain in the neck. The effect would be even more pronounced if one were in a speedboat and tried the same experiments with water at corresponding speeds. If, however, instead of placing the palm broadside to the air flow, one keeps it horizontal, then the force trying to push the hand is far less. These simple illustrations, sought after and experienced regularly by children in spite of protests from elders, can explain the major characteristics of aerodynamic drag.

Incidentally, one may also observe that if the palm is held slightly inclined to the direction of motion, there is a significant force trying to push it up. This is called the aerodynamic *lift* force—similar, in principle, to the force that makes an airplane airborne. The aircraft's extending wings are designed to develop a high lift. However, for ground vehicles and their normal speeds, this force can be neglected.

Our simple experiments will show that the aerodynamic drag depends firstly on the *relative* speed of the body with respect to the surrounding medium. That is why we stipulated *still air* in our experiments. Generally speaking, the greater the relative speed of the body with respect to the surrounding medium, the greater will be the aerodynamic drag. In fact, the forces experienced would be practically the same if the body is kept stationary and the air is made to move with respect to the body. This is the principle behind wind-tunnels and it



Popular Science

Car model being tested in a wind-tunnel streaks trace air flow over the body at various locations

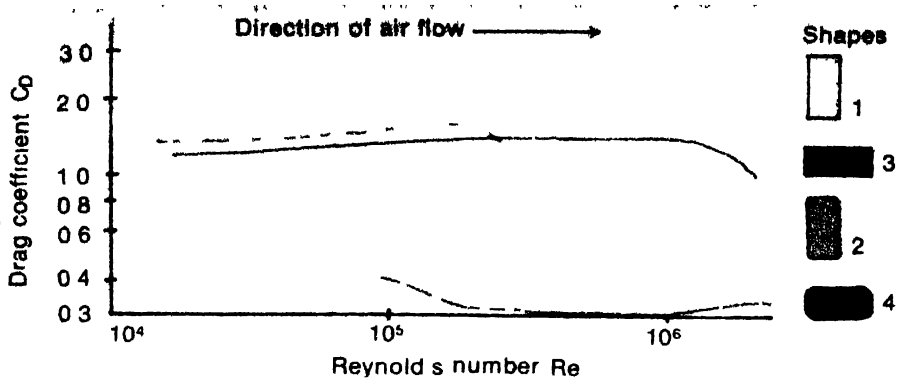


Fig 1 Shaping up to the wind Shapes 1 and 2 have heights equal to twice their lengths in the direction of the wind Shapes 3 and 4 have a more slender shape and their heights which are half their lengths in the direction of the wind are equal to the length of 1 and 2 The corners of the shapes differ in smoothness The corner radii of these shapes are 0 021 0 25 0 042 and 0 5 times their heights respectively Notice the sharp drop in drag coefficient at sufficiently high speeds for the smoother shapes particularly for shape 2

makes life a little easier for aeronautical engineers and allows them to get away without having to fly a plane for every test

The drag depends also on the properties of the medium for example its density Water being denser than air will offer greater resistance The size of the body also determines the amount of resistance experienced For the same *shape and attitude* (direction) a larger body will experience a larger drag

The shape and the attitude of the body with respect to the direction of motion are the most important factors which influence a ground vehicle's aerodynamic drag In transport the problem is to have as large a size and as high a speed of the vehicle as possible Decreasing the size or speed is, therefore not an effective way of decreasing drag The medium is of course, beyond the designer's control Thus, the factor which he can control is the shape and attitude of the vehicle

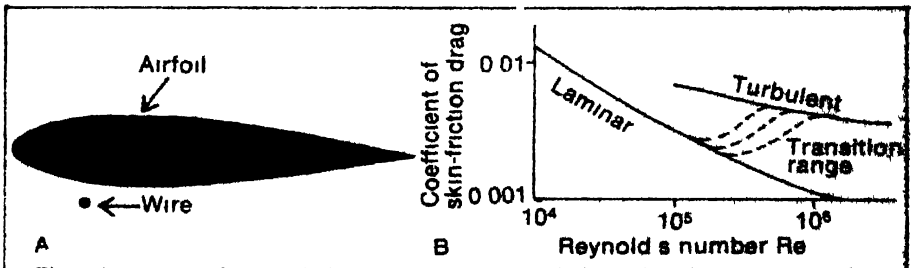
The aerodynamic drag experienced by ground vehicles has actually two components—form or pressure drag and the skin friction drag The aerodynamic drag is the sum of these two forces resisting the motion of the body

Form or pressure drag arises from the difference in pressure between the front and rear of a vehicle, caused by the separation of airflow A smooth, tapering and elongated shape guides the airflow along its surface without separation Bluff, uneven bodies break up the airflow and cause a separation, this results in the formation of a turbulent wake, similar to the swirl that follows a speedboat in water The size of the wake is an indicator of the separation of the airflow The larger the wake, the larger will be the form or pressure drag

Form drag, then, can be seen to be dependent on the shape of the body If the surface is made smoother, and given a continuous and elongated shape, form drag is considerably reduced This is called streamlining and such a shape is called streamlined because the airflow closely follows the contours of the body without separation The palm of the hand when held horizontal offers a streamlined shape to the airflow

But streamlining cannot be carried on indefinitely to reduce drag If that were possible, we could keep increasing the smoothness and relative length of a body In practice, it never works that way This is where the other component of the aerodynamic drag—the skin friction drag—assumes importance The skin friction drag is due to the tendency of the moving fluid to stick to the body surface as it flows past it This induces a force in the direction of the fluid flow Skin friction drag is dependent on the surface area of contact, between the medium and the body

Now, in streamlining a body, the increase in length will also increase the surface area Thus, while streamlining a bluff-shaped body will decrease the form drag, it will increase the skin friction drag Initially, the decrease in form drag will more than compensate for the increase in skin friction drag But not for long After a certain amount of streamlining, the decrease in form drag will no longer be able to compensate for the increase in skin friction drag There is thus a limit to which streamlining can reduce the total drag And while minimising



The advantages of streamlining It may be hard to believe, but the wire and airfoil shown at A experience the same drag in air in spite of the large difference in their sizes This is because of the low viscosity of air In a viscous liquid like glycerine, the airfoil will experience a much larger drag than the wire because of the pronounced effect of the skin-friction drag The effect of laminar turbulent and transition ranges of flow on drag are shown at B for various sizes and roughness

Skin-friction drag

One of the best ways of reducing form drag (or pressure drag) is to streamline the body This is achieved by reducing the ratio of the maximum thickness of the body to the length in the direction of air flow This results in a smaller deflection of air flow as it approaches the body and moves around it and then past it The boundary layer develops right from the leading (front) edge and grows along the surface and finally leaves the body in the form of a wake

The width of the wake is an indication of drag, the larger it is, the higher is the drag Obviously, a bluff body would entail a large wake because of the separation closely past the maximum thickness location (SCIENCE TODAY, September 1976, p 46) For a streamlined body, the wake will be much thinner A comparison of the size of a bluff body with a streamlined body having the same drag is given in the figure It is clear from this figure that even if a vehicle like the existing car is completely enclosed by such a streamlined body, the drag would still be less!

The skin-friction drag depends on the product of the viscosity and the transverse velocity gradient at the surface Compared to a laminar boundary layer, the gradient is much larger for a turbulent boundary layer, and so is the skin friction drag

A typical relation between the skin-friction drag and Reynolds number is shown in the figure. It must be remembered that beyond a certain Reynolds number called the Critical Re, the flow becomes turbulent in the boundary layer Surface roughness and unevenness reduce the Critical Re, increase turbulence and consequently the skin-friction drag

M M S

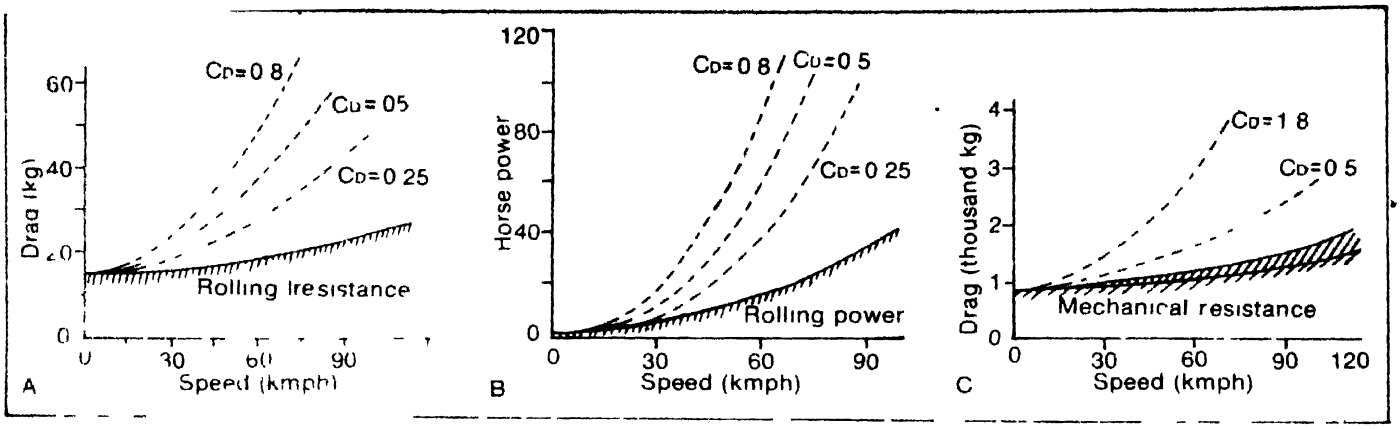


Fig 2 Drag and engine power rise steeply with speed The broken curves at A and B show the *total* drag and the engine power required to overcome it for different drag coefficients for a car The solid curve shows rolling resistance (or drag) and the engine power needed to overcome it At C we have the corresponding curve for drag of a train The shaded area shows the drag due to the substantial requirements of ventilation

drag one should remember that the total aerodynamic drag is a sum of both form drag and skin friction drag They may sometimes lead to conflicting requirements, depending on specific conditions

The total aerodynamic drag of a body thus depends on (a) the relative speed of the body and the surrounding medium (b) the size of the body (c) the properties of the medium and (d) the shape and attitude of the body The effect of the shape and attitude of the body is measured by the drag coefficient of the body

Aerodynamic coefficients of single shapes

The drag coefficient of a body is an important factor controlling fuel consumption It depends on a number of parameters The most important of these are the Reynold number (Re) and Mach number (M) (see box on p 51) The Mach number compares the speed of the body with the local speed of sound It becomes important only when we approach relative speeds nearing the velocity of sound At low speeds when the Mach number is lower than 0 3 it does not play a significant role For ground vehicles with speeds as high as 100 kmph, the Mach number is well below 0 1 and its effects can therefore be ignored Not however the Reynold s number It is a dimensionless number, very much a measure of the character of fluid flow It is a measure of the combined effect of the relative velocity the size of a body and the density and the viscosity of the fluid Most fluid characteristics along with the drag coefficient of a body, show important correlations with the Reynold s number

It is not generally realised how much a small honing and smoothening have to do with reduction of drag at higher speeds, and, consequently, with reduction of fuel consumption A look at Fig 1 will show that by simply increasing the corner radius, that is, by rounding the corners, the drag coefficient can be brought down from nearly 2 2 to as low as 0 5 for high speeds, a drop of nearly 77 per cent If we also change the attitude of the body, the drag coefficient can be brought down to 0 3 Streamlining, of course, can bring about a sharp fall in the drag coefficient of a bluff body at a certain Reynold s number, called the critical Reynold s number (for a given body, attitude and medium, this means a certain critical speed) This is when the flow in the vicinity of a body turns turbulent After the critical Reynold s number, and at higher speeds, there is a gradual increase in the drag coefficient due to the increasing skin friction drag

It is clear from these figures that we can lower the drag coefficients substantially by very simple mechanisms like altering the external shape of the body—streamlining, rounding the corners, eliminating projections and increasing the slenderness ratio Let us now take some specific categories of vehicles and examine their aerodynamic efficiency

Automobiles

Automobiles in motion are more complex than the simple shapes in our experiments Take a car, for instance The total resistance of a car consists of two components, mechanical and aerodynamic The mechanical resistance includes the ground friction rolling resistance in bearings transmissions, etc The aerodynamic resistance depends on the drag coefficients Fig 2 shows a typical variation of the total resistance and power for a car with changing shape and, therefore, with a changing drag coefficient C

Rolling resistance shows a gradual and marginal increase with speed But aerodynamic resistance shows a marked and rapid increase at higher speeds The difference is much more pronounced in the power required to overcome this resistance While the power required to overcome mechanical resistance varies practically linearly with increase in speed, the power required to overcome aerodynamic drag climbs much more steeply in fact, more steeply than the aerodynamic resistance Because of this, reducing drag coefficients will significantly reduce power requirements at higher speeds thereby saving fuel For the typical car shown in the figure, if the drag coefficient C D is brought down from 0 8 to 0 5 by proper design, fuel requirements in the 60 to 100 kmph speed range can be brought down easily by 10 litres per 1000 kilometres It will amount to a saving of Rs 52 per 1,000 km for cars using petrol

We should however, keep in mind that this fuel saving is significant only for higher speeds For low speeds, it will not be very significant Those who use their cars within city limits, mainly for commuting and for city travel, will rarely reach such speeds in India Fuel-saving by aerodynamic design is quite significant, however, for trucks and trains as both travel long stretches at fairly high speeds So also will it be for car owners who frequently travel long distances

Aerodynamic drag

Aerodynamic drag can be represented by a simple formula,

$$D = \tfrac{1}{2} C_D \rho V^2 A$$

Here D is the drag arising from the movement of the body relative to air;

C_D is a non-dimensional parameter called the drag coefficient;

ρ is the density of air;

V is the relative velocity of the air with respect to the body;

A is the reference area of the vehicle.

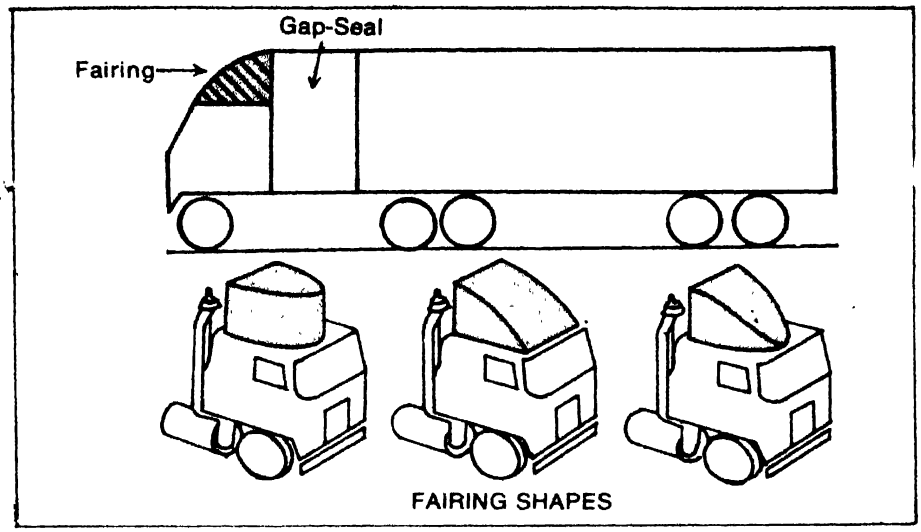


Fig. 3 Smoother foreheads and sealed gaps can reduce drag substantially

Tractor trailer trucks

Tractor trailer trucks have some problems in common with trains and also with simpler ground vehicles like cars, minibuses, vans and trucks. It would be interesting to see how aerodynamics affects their design. The aerodynamic drag typically accounts for about one-half of the fuel consumption of such vehicles. Since their bluff bodies, which have sharp corners and break up airflow, are characterised by high aerodynamic drag coefficients, drag reduction offers a big potential for fuel conservation

A substantial part of the aerodynamic drag of a tractor-trailer truck is caused by the inefficient manner in which the air flows around the trailer. Depending upon the particular combination of tractor, trailer and the gap-width between them, this may represent as much as one-third of the total aerodynamic drag of a cab-over-engine tractor-trailer moving in still air. The reason for this appreciable drag is the flow separation which occurs at the forward edges of the trailer near the gap. Here the air flowing past the tractor impinges on the exposed front-surface of the trailer and separates at its forward edges (Fig. 4). This is how separation of flow occurs for trains also. For trucks, the problem is similar but without the complicating gap.

The problem becomes more serious when the truck makes an angle of yaw (angle between the direction of motion of the truck and the wind direction). In such cases the airflow has a horizontal component across the front face of the trailer, and this greatly increases the separation at the trailer's leeward side. This flow is also responsible for lateral aerodynamic forces on the vehicle leading to problems of stability. The gap crossflow is responsible for a significant portion of the aerodynamic drag even when there is no yaw angle. The airflow separates and flows upwards and downwards through the gap. However, as the yaw angle increases, the flow pattern in the gap changes. A significant amount of air flows across the gap and separates from the trailer face as it progresses beyond the leeward side of the gap. Both the lateral and normal drag on the vehicle increase.

The most effective way to deal with this problem is to decrease the size of the gap, or better still, to seal the gap. Sealing the gap need not interfere with the flexibility of the trailer truck. The gap-seal can be flexible and folding. A reduction of drag coefficient by 0.05 or more is possible for existing trailer trucks. Another way of reducing the drag due to the gap is to use fairings (fairings, shown in Fig. 3, are additional pieces suitably shaped to ensure a smooth variation in airflow). An appropriately designed fairing can bring about a reduction of 25 per cent even without a gap-seal or 32 per cent with gap-seal. Even without the fairing, at an average speed of about 90 kmph, with a fuel consumption of 0.184 kg per horse power per hour, fuel-saving by a gap-seal alone can be of the order of nearly 20 litres for every 1000 km or Rs. 45 per 1000 km. The general brake specific con-

Modelling aerodynamic situations

It is time-consuming and prohibitively expensive to make and test all configurations with an actual vehicle. Hence engineers resort to modelling. The vehicle is scaled down geometrically and subjected to aerodynamic loads similar to those that would actually be experienced. A problem now arises of how to ensure that the results of model tests can be reliably extended to full-scale operating conditions. This is done by satisfying certain conditions which ensure dynamic similarity. The Reynold's number (Re) and the Mach number (M) are two fundamental dynamic similarity parameters. When these two parameters are the same for the full-scale and the geometrically similar model, the flow field and the aerodynamic load distribution will be similar in the two situations.

Reynold's number (Re) : In physical terms, the Reynold's number represents the ratio of the inertial force and the viscous force experienced by the body. When it is small (for example, lower than 3×10^5 for a flat plate) the flow very near the surface is smooth—called *laminar flow*. Above this value, the flow will become *turbulent* even very near the surface. Roughness of the surface and disturbance in the basic flow have a tendency to increase turbulence.

$$Re = \rho \frac{VL}{u}$$

Where ρ is the fluid density

V is the velocity of the body with respect to the fluid

L is the reference length

μ is the fluid viscosity.

If all other conditions are same, the same value of Re for model and prototype ensures that the flow structure close to the body would be the same. For bodies like automobiles and trains, the flow structure close to the surface almost entirely determines the [illegible] aerodynamic drag.

Mach number (M) : The Mach number is the ratio of the velocity of a body to the local velocity of sound in the medium. One may legitimately wonder what the velocity of sound has to do with aerodynamics. The speed of sound is an indicator of the speed with which a disturbance spreads in the medium. If the body is moving with a velocity less than the speed of sound, the disturbance its motion creates leads and, in a way, "prepares" the fluid medium to "make way" for the body. If the body moves at speeds faster than those of sound, then this "preparation" cannot take place and the surprised medium, on which the body descends, gives out shock waves! This is what happens with a supersonic jet. Fortunately, this characteristic only becomes important for speeds approaching the speed of sound. For normal speeds of ground vehicles, the Mach number practically has no effect on the aerodynamic drag.

M. M. S.

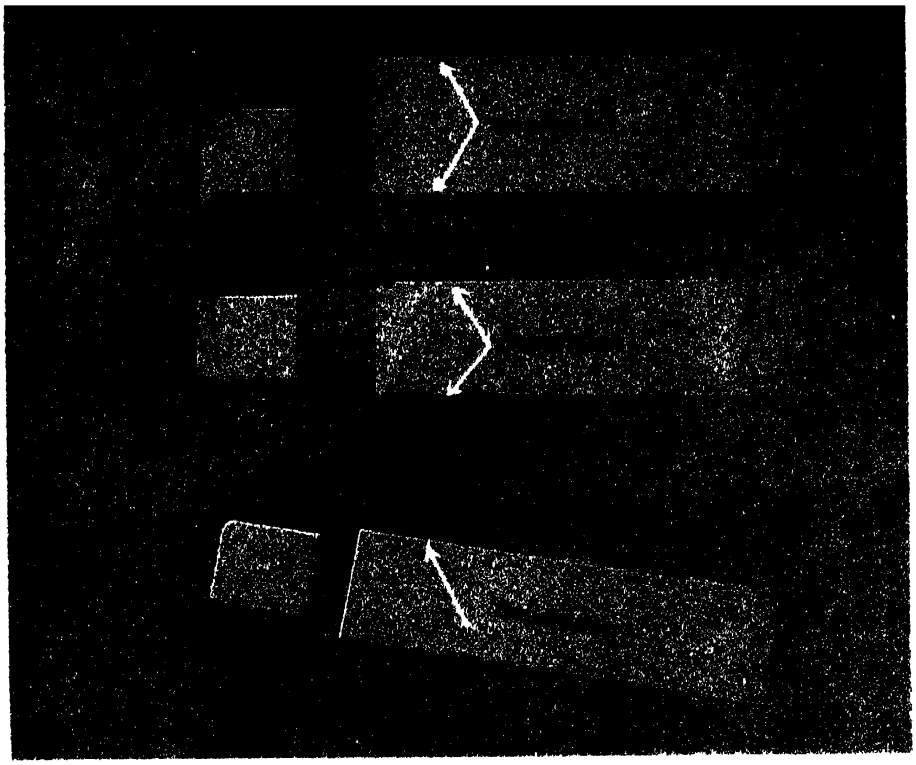


Fig 4 Air flow separation at a tractor trailer truck A and B show the separation at the forward end of the trailer for a truck running squarely into the wind C shows the separation for a yawed truck moving at an angle to the wind direction A yawed truck has a very large separation at the leeward side and the loss of symmetry can cause problems of lateral stability

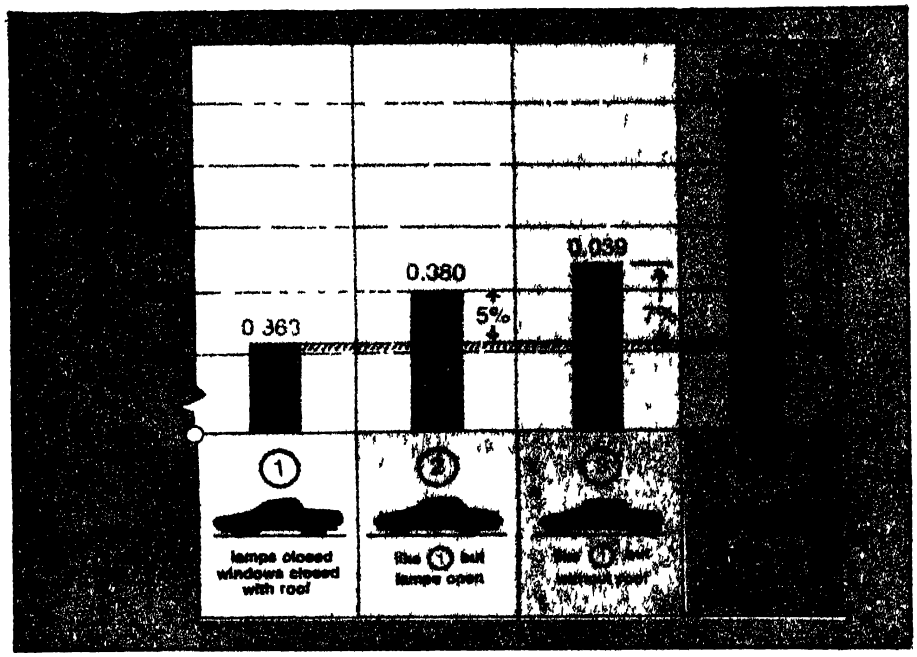


Fig 6 Functiona parameters affect the drag coefficient A simple thing like having the lamps out can add five per cent to the drag coefficient

sumptions in India are higher and the actual saving would be expected to be still higher

Another attractive proposal is to use turning vanes to prevent flow separation at the edges A typical cross section of a turning vane is shown in Figure 10 The upper part of the vane extends from the bottom of the windshield right up to the top and the lower part from the top of the bumper to just below the windshield When turning vanes are added where the front edges have a small radius, they produce very small drags Vanes with 90° turning angles produce the minimum drag Similar results are obtained by locating turning vanes at

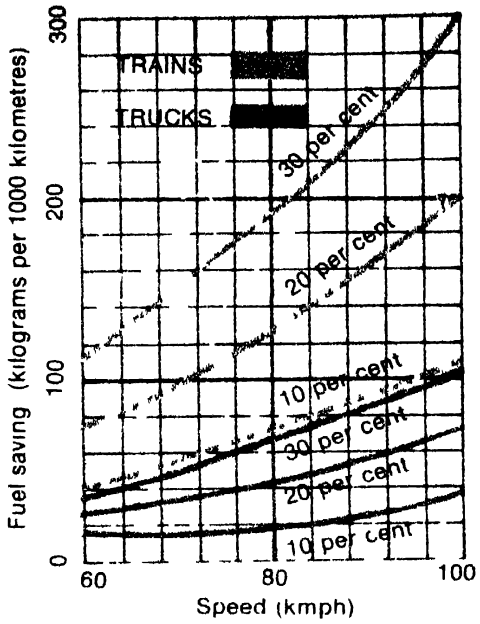


Fig 5 Fuel saving with reduction in drag coefficient of trucks and trains Figures at the curves represent the percentage of reduction in drag coefficients Even with a 10 per cent reduction in drag the fuel saved (for trains) could be about 40 kg per 1000 km

the rear This technique could be quite useful for the numerous vans and minibuses plying on our roads Besides, with turning vanes on vans and minibuses (small bonus is thrown in—they also protect the driver from sunglare

Not many long tractor trailer trucks ply on our highways But there is considerable scope for improvement in the external configurations of our trucks The principles discussed about cars apply equally well to our trucks vans and minibuses Conservative estimates of the reduction in fuel consumption could be put at 10 to 20 per cent without affecting the cargo carrying capacity

Functional states and shapes

Before the oil squeeze came, stylists invariably had the last word as far as the external shape of a car was concerned The changed circumstances have brought them and the aerodynamicists together right at the preliminary design stage in order to develop aesthetically goodlooking, comfortable automobiles, combined with good mileage and speed Although the maximum speed is mainly determined by the power of the engine, with improvements in the design of the car, it would be possible to have increased speeds and higher accelerations with the same engine Besides, mileage would also be increased with reduced resistance at a specified speed The design of the main body and its shape, of course, plays a major part in the aerodynamic

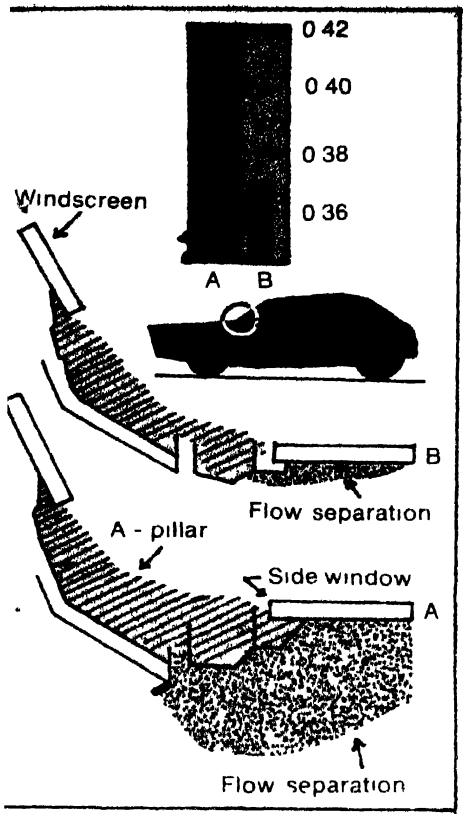


Fig 7 A pillar or front roof support design In the two designs shown the inefficient design at the bottom causes a much larger separation

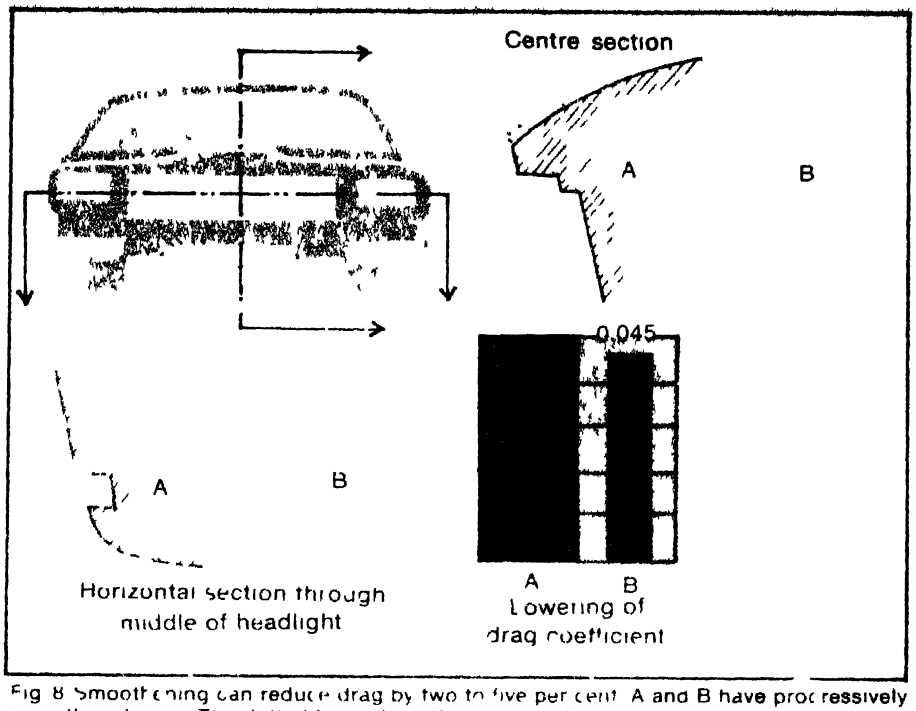


Fig 8 Smoothening can reduce drag by two to five per cent A and B have progressively smoother shape The dotted lines show the original shap

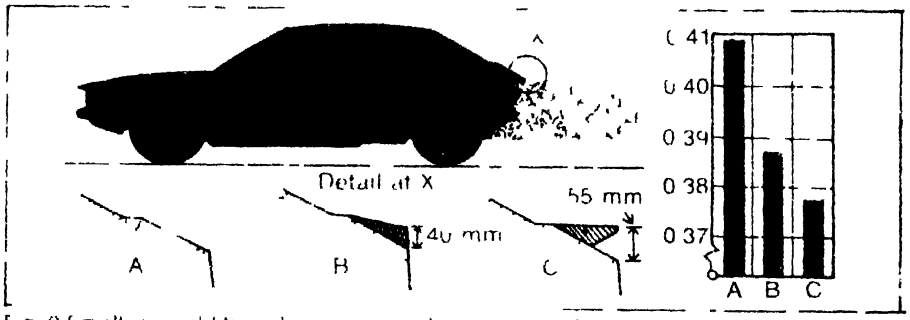


Fig 9 Small car additions known as spoilers can contribute towards reducing drag coefficient

characteristics of a car But even small details matter

Besides the main shape of the body (which remains the most important factor) functional parameters also control aerodynamic drag Functional parameters refer to the functional states of different parts of the vehicle such as whether the radiator is open or blanked retractable head lamps are in or out and windows open or closed Fig 6 shows how drag is influenced by the equipment of the vehicle A simple functional state like having the lamps open can add five per cent to the aerodynamic drag while leaving roof and windows open can add nearly 23 per cent to the aerodynamic drag for the same speed Thus one of the first and simple steps will be to improve the aerodynamic efficiency of functional designs This consists of subordinating the functional parameters to the overall requirements of the main shape by making most functional elements flush with the body

Some features, which are added for convenience, can add to aerodynamic drag for long-distance travel Thus, provisions for carrying load on top would have to pay the penalty by increasing drag by 2 to 5 per cent For long distance travel, it is best to have a larger storage capacity at the rear Protruding head lamp covers which are so common even for some trucks could be adding another 5 per cent or so

Not all additions however increase the aerodynamic drag Some additions made for convenience can actually reduce drag An example is the small flap that so many taxi cabs have at the top of their windscreens to reduce glare These flaps, especially when they have a small gap between them and the windscreen actually serve to reduce drag What is needed, especially for automobiles which are to be used for long-distance travel is to give serious thought to the aerodynamic consequences of additions More sophisticated design and windtunnel experiments could also help the designer to fix the optimum location for air intakes or outlets for cooling, ventilation and the like All of them would contribute to reducing aerodynamic drag

Yet, the main shape of the body remains the most important factor The front shape of the vehicle is particularly important since, for passenger cars, the front is approximately fixed by the position of the engine, front bumpers, head lamps and traffic lamps which also have to meet the demands of law Fig 8 shows the influence of differently shaped front edges of the bonnet on the aerodynamic drag for a passenger car Successive degree of rounding of the end-shapes can reduce the drag coefficient by more than 0 04 The front pillar (or A pillar), which houses the windscreen and the side window edges and supports the roof, is another important item, a changed design can reduce the drag by another 0 04 (Fig 7)

The rear end geometry depends on the angle of inclination of the rear support and the height of the horizontal rear edge There is no simple relation between these parameters and only windtunnel tests can determine the optimum design A tested design could reduce the drag coefficient by nearly 0 05 Another rear-end feature is the addition of a modified end-shape called the rear spoiler The design modifications shown in Fig 9 can bring about another reduction of 0 02 to 0 03 in the drag coefficient

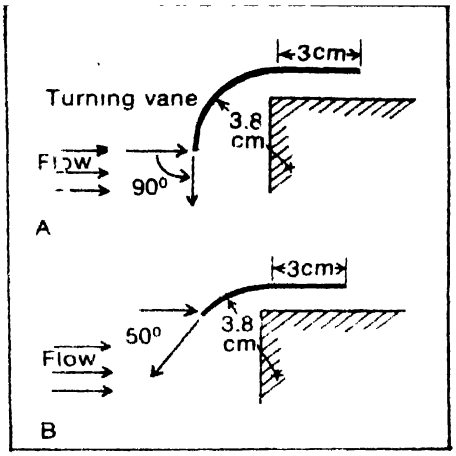


Fig 10 Turning vanes are attachments that guide air flow smoothly around the body A and B show typical cross-sections of a 90 degree and a 50 degree vane, respectively

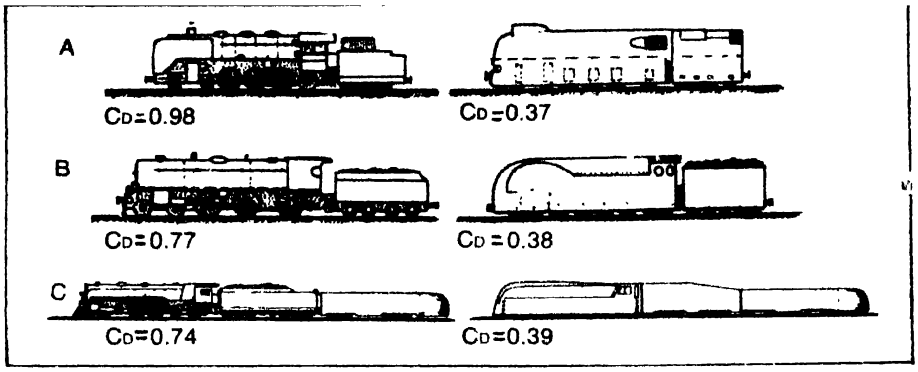


Fig. 11 Streamlined locomotives have a substantially lower drag coefficient than standard shapes

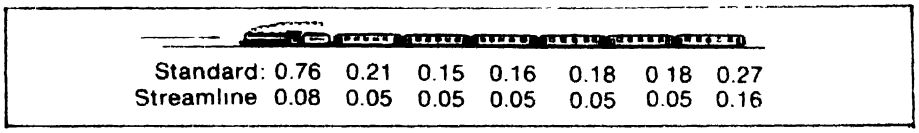


Fig 12 Theoretical potential of drag reduction of trains Figures show drag coefficients of each part of a six-compartment train for the standard and fully streamlined shapes The total drag coefficient could be brought down from 1 9 to 0.5 with full streamlining

All the modifications discussed are relatively simple and while, only small details need to be modified, the overall shape of the car remains streamlined. The protruding parts can be easily eliminated and made flush with the body; small additions like spoilers can be as easily added. Incorporation of all the changes mentioned above could easily reduce the drag coefficient by 0.16. Even for an otherwise well-designed car, a lowering of the drag coefficient by 0.2 means a saving of about Rs. 35 per 1000 km for cars using petrol and for trucks using diesel at current prices.

Trains

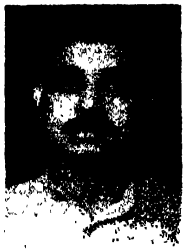
Cars and tractor-trailers are not the common modes of transport in India. But trucks and, especially, trains are important in the Indian transport system. The Indian Railways operate one of the world's largest transportation networks. The normal speeds of Indian trains have been increasing in the past few years. Today the fleet includes a large number of superfast express trains for passenger as well as cargo transport. And even a small reduction in drag coefficients could result in large savings.

For a train, much of the drag comes from the engine itself. Some of the experimental shapes shown in Fig. 11 can reduce drag by 50 to 65 per cent for single engines. This, however, is a neglected area and we do not have readily available data for field tests of working models. A streamlined frontal part of the engine with a well-rounded bullet nose could significantly reduce the drag by deflecting the air smoothly around itself and the following carriages. Studies available for simulated streamlined models show that there is scope for dramatic reductions in the drag coefficient of the entire train. Fig. 12 gives comparative values for each section of the train and its streamlined version. The practical values may, of course, not be as small as this, but they indicate the potential.

Fig. 2(c) shows the variation with speed of the drag of a six-compartment train with engine. If we succeed in bringing down the drag coefficient of a train from 1.8 to 0.5, even at 60 kmph there could be a 50 per cent reduction in drag. But let us not think in terms of terminal values at all. The fuel-savings possible with 10, 20 and 30 per cent reduction (very modest estimates corresponding to C_D around 1.6, 1.4, 1.3, respectively) are shown in Fig. 5. Even with a 10 per cent reduction we have a saving of more than 60 kg of diesel per thousand km or Rs. 173 per 1,000 km at current prices.

In the case of trains, proper gap-seals between compartments including the engine, may go a long way in reducing drag. Gap-seals are used today only for a few trains and their main use is seen as providing continuous vestibules. It is not realised that their proper design, besides its importance in drag reduction, helps provide lateral stability. Without a gap-seal, the crossflow across the gap increases lateral instability. For superfast trains negotiating difficult bends while running into a cross-wind, lateral stability could be a serious problem, which could even lead to serious accidents. Again, the solution is not simply to seal the gap airtight, it is not certain that this would overcome the problem. What is needed is a design based on actual experiments and tests.

It should be emphasised that all the modifications suggested above *do not* interfere with any of the internal arrangements of the vehicles. They refer only to external shapes. So nothing is lost in passenger comfort or facilities. In fact, more sophiscated studies could not only help reduce aerodynamic drag, but also simultaneously suggest modifications for improving the ventilation of passenger compartments, especially of suburban trains. A closer control of aerodynamic drag could be possible by the sophisticated application of boundary layer control. But these are future steps. Immediately, we need to give sufficient weight to the simpler mechanisms of reducing this drag, specially when they mean substantial savings of effort, foreign exchange, materials and sorely needed energy sources.



Dr Sivaramakrishnan is Assistant Professor at the Department of Aeronautical Engineering at the Indian Institute of Technology, Bombay. He got his M E in Aeronautical Engineering from the Indian Institute of Science, Bangalore, and Ph D from the Moscow State University. His major research areas in aerodynamics are drag mechanisms, drag reduction techniques and aircraft design Besides, he also has industrial experience, having worked with Hindustan Aeronautics Limited.

Recommends reading: 1. *Fluid Dynamic Drag*, S. F. Hoerner published by the author, New Jersey, 1965. 2. *Advances in Road Vehicle Aerodynamics*, BHRE Fluid Engineering, 1973.

Modern science for children watch out for errors

The Mighty Little Atom by A P Thatte IBH Publishing Company Bombay 1980 32 pp Rs 6

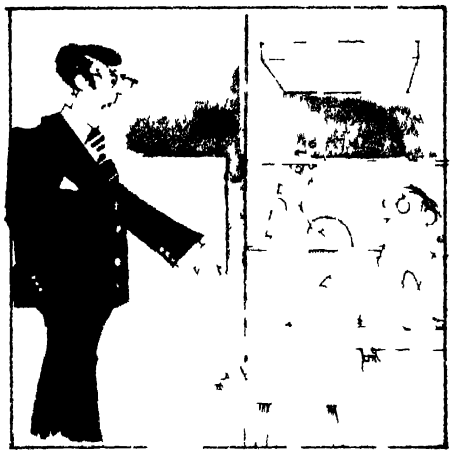
It is heartening to see an Indian publisher venturing to publish a series on modern science for young people This little book is the first of a series on basic science The author has made a serious effort to present the details of atomic structure simply and has succeeded He also explains what nuclear fission and fusion are All this should be comprehensible to school children in their later years in school A large number of illustrative colour diagrams add to its attractiveness

But there are also some shortcomings The author has not distinguished clearly between the atomic number and the atomic weight of an element The former is simply the sum of the numbers of protons and neutrons in the nucleus whereas the latter the mass of the atom measured in the atomic mass unit (which is one twelfth of the mass of the neutral unexcited C atom) There is a small difference between the two which is of very great importance And then deuterium is incorrectly stated to be radioactive (p 22) The author postulates the elastic force as distinct from the chemical force (p 23) whereas we know that there are no such forces There is only the electromagnetic force which holds atoms and molecules (and us) together Particular attention should be paid to the accuracy of statements in a book for the young because they tend to accept the printed word as gospel truth The bane of the school books produced by our school boards is that they are replete with errors The same pattern should not be repeated in popular science books written by scientists

Lastly while it is a good idea to include biographical sketches of great scientists they occupy a disproportionate amount of space in the book Some of them are carelessly compiled For instance it is stated that Niels Bohr became a professor in Cambridge Did he Also he has not developed the quantum theory *with* Sommerfeld The portraits of the scientists have in most cases only hypothetical resemblance to the originals Surely the publisher could have employed a more talented artist!

B BANERJEE

Dr Banerjee is with the Theoretical Physics Group Tata Institute of Fundamental Research Bombay



Why do you need to be lethargic in the [illegible] winters? The reason I think is [illegible] The genes probably [illegible] which makes them bulk

NO COMPETITION

Sole Agents
Electronic Enterprises
Post Bag No 6367, Sewri
BOMBAY 400 015

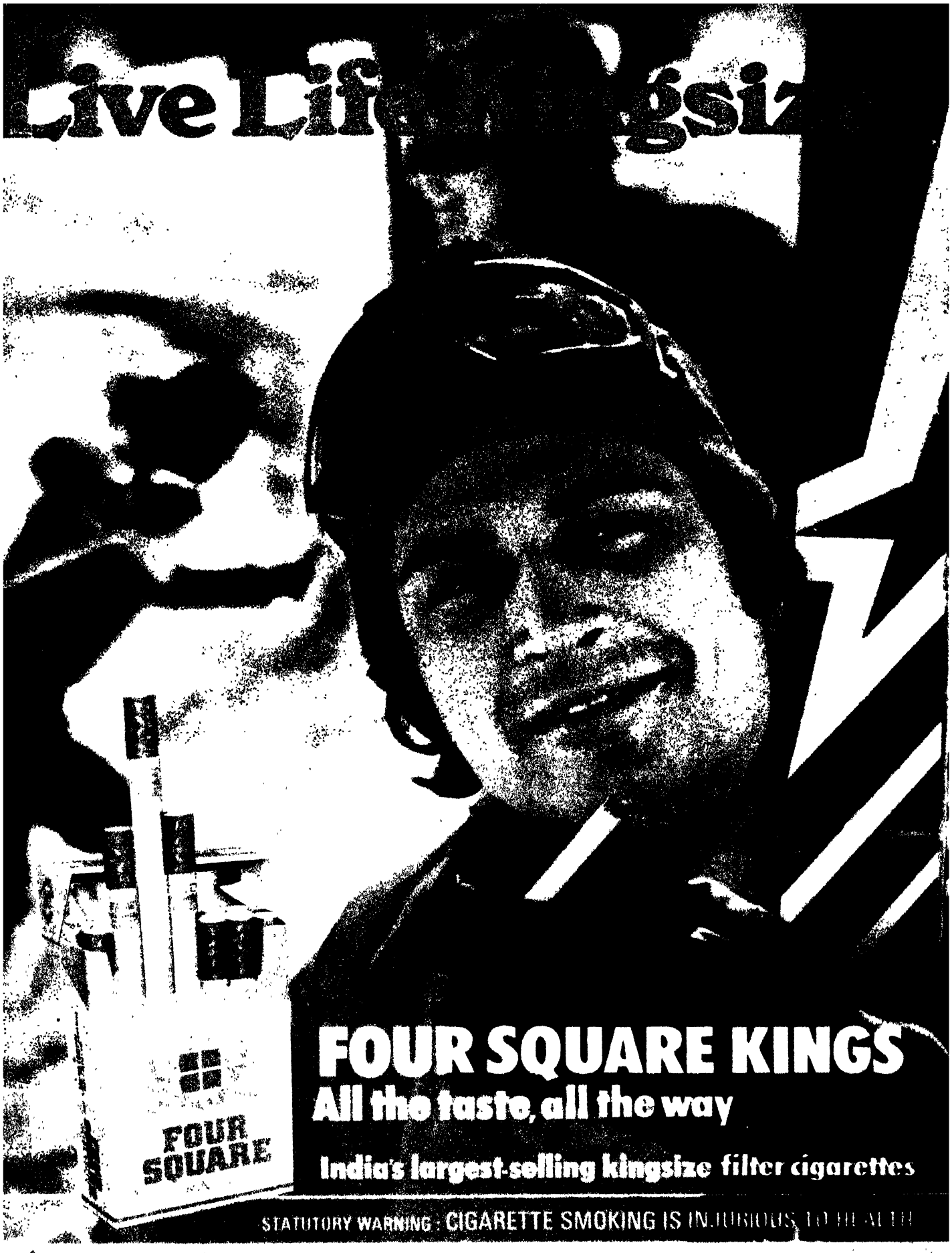


These are the world's finest hygrometers made by the original manufacturers for over 30 years Just look at this impressive list of features

	SHAW	OTHER MAKES
Instantly interchangeable sensors	✓	
Two year guarantee	✓	
Automatic calibration (carried out in one minute without any skill or equipment)		
No skill needed	✓	
Calibration verification in one minute	✓	
Calibration of sensor and instrument together (not with dummy resistors or capacitors)	✓	
Fixed zero		
Automatic dry down before next test (portable model)		
Practically no maintenance required		
No pumping temperature measurement manual adjustment or conversion tables needed		
No corrections for different gas samples		
Robust sensor designed for industrial use	✓	
Ex stock delivery of most standard models		

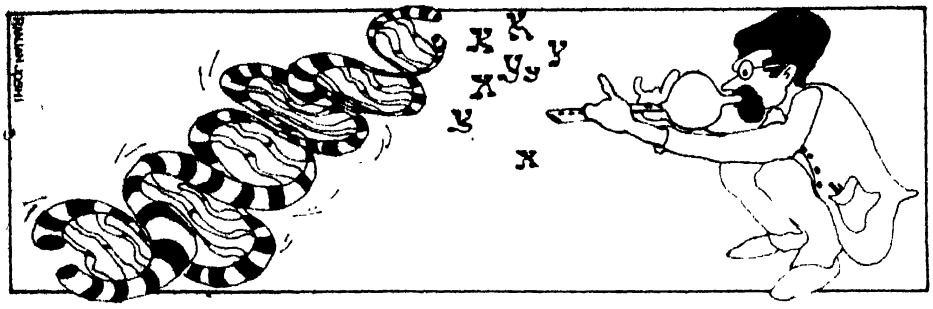
With more experience than anyone else in the business, and more than three quarters of our production being exported literally world-wide, we can more than justify our position as the best in the world

SHAW **Be sure — Buy Shaw *Moisture Meters***
Bradford, England. Tel: 0274 33582. Telex: 51598.



GODFREY PHILLIPS INDIA LIMITED

How much do you know about GENES and HEREDITY?



What do you know about the factors that control our systems, organs and cells in health and disease? Here is a multiple choice test to evaluate yourself. Each item (from 1 to 10) has five choices. There is only one correct or most appropriate selection among the choices. Choose the answer which you think is correct for each question. Turn the page to see how right you were.

1. The well-known "Mendel's laws", remained unknown till 1900. They were rediscovered by three biologists. One of these was Erich von Tsehermak-Seysenegg of Esslingen near Vienna. Among the other/s was/were: A. Theodor Boveri. B. Hugo de Vries. C. Carl Correns. D. A and B. E. B and C.

2. Genetics is a science where conclusions from experiments on one species are transposable to another. Several scientists have won the Nobel prize for their work on such models as the fruit-fly, fungi and bacteria. Among them was/were: A. Thomas Hunt Morgan. B. George Wells Beadle. C. Joshua Lederberg D. all the above. E. A and C.

3. Landsteiner was awarded the Nobel prize for his work on the ABO blood group system. These groups are genetically controlled. If both parents are of the "A" group, to what group/s can their children belong? A. –"A" B. –"O". C. –"B" D. – A or B. E. All the above.

4. Hemophilia is a bleeding disease where all the following are true except: A. It is always found in males. B. It is a hereditary disorder. C. It is usually transmitted through females. D. A hemophilic's blood can be used in a transfusion to "cure" the severe bleeding of another hemophilic. E. In the usual form, a father cannot pass the disease or the gene to his son.

5. With regard to the determination of sex, all the following are true except: A. In the human, the sex of a child is determined at conception. B. The sex of a child is genetically determined. C. Twins of the same sex must be of the same blood group. D. Sex ratios at birth can be altered by environmental conditions. E. The day of intercourse in relation to ovulation may affect the sex of the offspring.

6. With regard to diabetes, which of the following is/are true? A. If a young person develops diabetes, the chances are that he has inherited the condition. B. A person has a greater chance of developing diabetes if both parents are diabetics. C. A latent diabetic can always be detected by careful urinalysis. D. A and B. E. All the above.

7. With regard to the following two statements: (i) The rare "Bombay" group is a form of the ABO system where a person is really of the "A" (or "B") group but appears to belong to the "O" group because (ii) his blood reacts with both "A" and "B" type sera. A. Both statements are correct and the reason is applicable. B. (i) is wrong. C. (ii) is wong. D. (i) and (ii) are wrong. E. (i) and (ii) are correct, but the reason is not applicable.

8. With regard to the following two statements: (i) In a paternity suit, a putative father can be positively identified by knowing his ABO group that of the mother and of the child because (ii) ABO groups are hereditary or genetically determined. A. Both statements are correct and reason applicable. B. (i) is wrong. C. (ii) is wrong. D. (i) is (ii) are wrong. E. (i) and (ii) are correct but reason not applicable.

9. For a kidney transplant, in the absence of an identical twin, which is the most acceptable donor? A. Fraternal twin. B. Type-matched first degree relative. C. Cadaveric donor. D. All the above. E. None of the above.

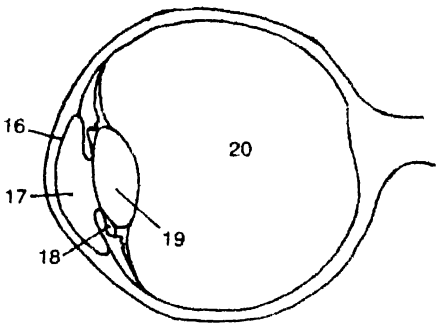
10. While generally the male and female sex are easily discernible in the human, the following are reliable criteria: A. The BB test from a mouth scrape. B. The secondary sex characters. C. The "drumstick"—found in blood smears. D. A and B E. A and C

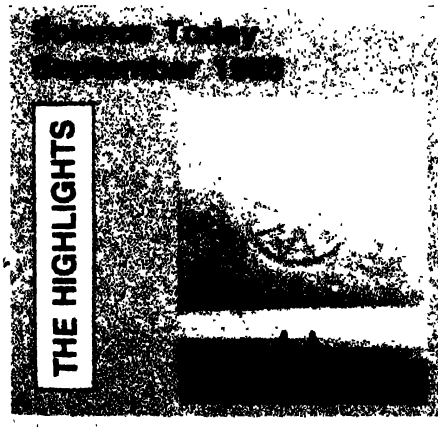
11-15. Match the following:

11	Adult neurone	A.	Secretary organelle
12	Mitochondrion	B.	Non-dividing cell
13	Golgi apparatus	C.	Respiratory enzymes
14	Centriole	D.	R N A
15	Nucleolus	E.	Cell division
		F.	Mesodermal cells

16-20. Match the lettered words to the numbers in the diagram.

A. Vitreous B. Lens. C. Anterior chamber. D. Cornea. E. Posterior chamber F. Choriod.





The ultimate constituents of matter

Centuries of efforts have revealed that all matter is made up of tiny elementary particles. Are these the ultimate constituents of matter?

Energy from the sea

could give us endless amount of energy.

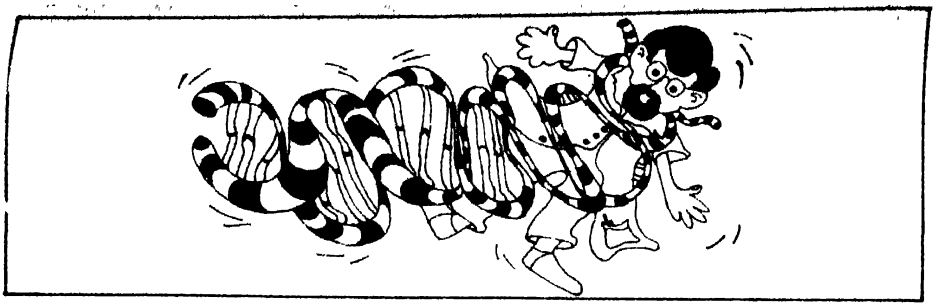
Rabies

How is it that rabies is still with us?

Aerobatics

The art of performing stunts in the air.

One year after UNCSTD



The Answers

1. — E: Mendel presented the results of his experiments before the Natural History Society of Brunn in 1865 and published them in its "Transactions". However, they remained largely hidden because the scientific world was not really prepared to accept them—they were far advanced and ahead of the times. They were independently rediscovered by three biologists. The other two were Carl Correns of Tubingen and Hugo de Vries of Amsterdam. However, good scientists as they were, they gave the credit to Mendel after whom the laws are now called.

2. — D: All the three. Morgan in 1933, for research on the nature of the gene. He and his students Calvin Bridges and A.H. Sturtevant were the first to draw the most fundamental conclusions using *Drosophila melanogaster* — the Brazilian fruit-fly.



Lederberg



Beadle



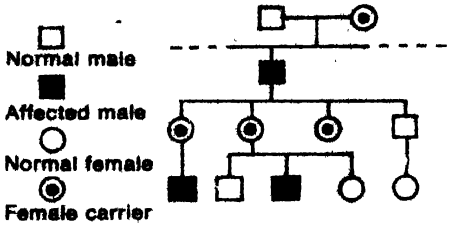
Tatum

George Beadle and Edward Tatum in 1958 for their work on biochemical genetics working on the "one gene - one enzyme theory" using a fungus, together with Lederberg for the discovery of sexual recombination in bacteria.

3. — D: A person who is by the usual test grouped under "A" may also carry the gene for the "O" group. In case of an "O" group, the gene does not effect a reaction against the specific serum to indicate either the "A" or "B" group. Thus, no reaction for a "B" group would be possible in the question cited as the parents do not carry this gene.

Genotype		Phenotype
I^A	I^A	A
I^A	I^O	A
I^B	I^B	B
I^B	I^O	B
I^A	I^B	AB
I^O	I^O	O

4. — A: The common form is usually sex-linked or due to a defective gene present



Pedigree of an X-linked recessive trait. X-linked recessive traits like colour blindness and certain forms of hemophilia are transmitted through the female to the male. An affected male can not have an affected son or daughter unless his wife is also a carrier of the disease. This does not usually happen in the case of a hemophilia like disease where the daughter has seen the father suffer. (An affected male's daughter is bound to be a carrier of the disease.) In case of a disease like colour blindness it is more probable that a carrier female marries an affected male

on the X chromosome. A male has an XY chromosomal make-up. If his X chromosome has this defective gene he will exhibit (or suffer) from the disease. He passes this gene to his daughters who get his X chromosomes but not to his sons as they are sons by virtue of receiving his Y chromosomes. There are, however, three forms of hemophilia. One is not sex-linked and hence girls can suffer from this form as likely as boys. The other two forms are each for a different clotting factor and, hence, in a transfusion can make up for each other.

5. — C: The sex of a person is genetically determined. The X, Y chromosomes are important in determining sex. The male is XY, half his sperms are X-bearing and half Y. Female eggs are all X-bearing. Though monozygotic twins—that is, those resulting from one egg and one sperm—must necessarily be of the same sex and also of the same blood group, the converse is not true. Twins of the same sex can be a result of two eggs and two sperms (fraternal twins) and hence can have a whole host of dissimilar characters including blood groups. Sex ratios are considerably shifted in times of severe stress like famines and war. The timing of intercourse can also play a role in whether an X or Y-bearing sperm is hindered or helped since the reaction and mucus in the female passages change as ovulation becomes imminent.

6. — D: Diabetes is a disease where carbohydrate metabolism is disturbed by the inability of the pancreas (islet cells of Langerhans) to metabolise sugar adequately. The tendency to this failure can be genetic especially in the condition known as juvenile diabetes or the diabetes that appears in the young. In latent diabetes the pancreas may be beginning to fail but not to the extent that the sugar appears in the urine. This can be therefore better detected by blood tests even though the urinalysis does not reveal anything.

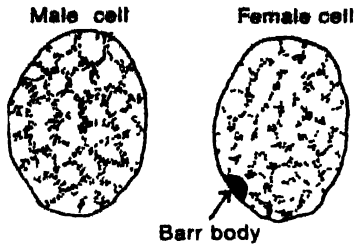
7. — C: The "Bombay" group is due to a suppressor gene where the person, though really belonging to group "A" or "B", does not produce the agglutination reaction due to this "suppressor gene". So he seems to be "O" group. This group was first discovered in a Bombay family.

8. — B: Knowing the ABO groups of all concerned may in some cases enable one to exclude a putative father because (ii) is correct. However, there could be so many of a possible group that it is too circumstantial to positively identify. Positive identifications can be made when several genetic markers can all implicate a particular person as to make the circumstances statistically significant.

9. — B: Tissue type matching is most important to determine the suitability of a donor for kidney transplant. Hence B is the most appropriate answer. A fraternal twin need not have even a matching blood group, leave alone other matching genetic tissue type characters.

10. —E: The sex of an individual is chromosomally determined. The heterochromatin on sex chromatin or Barr body (BB) as it is called is dependent on the number of X chromosomes. This can be demonstrated by a smear made from a mouth scrape. So also the drumstick in a blood smear represents this same heterochromatin. Thus, in a way, they are markers for a genetic XX or female make-up and are reliable indices of the chromosomal pattern. Secondary sex





characters, on the other hand, can be modified by so many variables including exogenous factors that they are not reliable indicators, especially when there is some doubt

11. — B Neuronal cells after an early age do not divide Hence, once destroyed cannot be replaced

12. — C A mitochondrion (mitos - thread) is a tiny little body full of enzymes especially the respiratory enzymes which help to store energy for the body Hence they are often called the power house of a cell

13 – A The Golgi apparatus is a collection of little tube-like structures and are concerned with a cell's production of secretions

14 – F The centriole is a wonderful little structure occupying a particular position in relation to the nucleus and dividing into two its components move to establish the poles and hence the equator of a dividing cell

15. — D While the chromosomes in the nucleus are almost all DNA the nucleolus is almost totally RNA

16. — D The cornea is the transparent window without blood vessels or lymphatics and can be replaced from a cadaver in corneal transplants

17 — C The anterior chamber is in front of the iris and it is here that the fluid is formed

18 – F The posterior chamber is absorbed In cases where production is faster or more than absorption the pressure rises in the eye—condition known as glaucoma

19. — B The lens lying behind the iris, separates the posterior chamber from the vitreous

20. — A The vitreous is a jelly like substance which fills most of the eye behind the lens

E J de SOUZA

Dr D Souza is a cytologist at the Jaslok Hospital and Research Centre Bombay

MEDICAL COLLEGES ADMISSION TESTS

6 GOLD MEDALLISTS IN 1979 ALONE



RAVI BHATIA
I D U (Combined)
V AFMC Selected
AIIMS & Merit ISCE Board



ANITA AGARWAL
I I H M C
Selected AIIMS

SUCCESS HAS BEEN A TRADITION WITH US

We have shaped the careers of thousands, why not yours now

Postal Course :
For non-Delhites only



SANGEETA ANAND
I AFMC



SANJEEV SAXENA
II D U (Combined)
Selected AIIMS
AFMC & JIPMER

Write to

DELHI PUBLIC COLLEGE OF COMPETITIONS

5-B, Pusa Road, New Delhi-110005 Phones · 587660 & 583108

N B —Our students captured 30 1st Positions in 6 years in All India Medical/Engineering Competitions



NAVAL BHATIA
I MGIMS Wardha

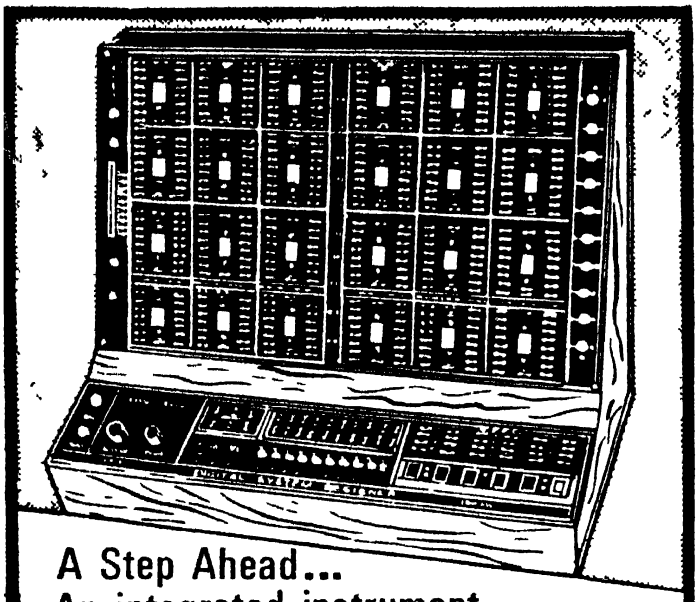


PAYAL CHOPRA
II AFMC

AMITABH MANCHANDA
M A (Dll) B Tech (I I T)
CHIEF ADMINISTRATOR

K. L. MANCHANDA
M A (Hons in Maths)
PRINCIPAL

PRATAP DPC-880



A Step Ahead...
An integrated instrument for integrated circuits...
AEC DIGITAL SYSTEM DESIGNERS

MODEL DSD-3

Versatile and self-contained laboratory demonstrator Plus a digital system development instrument to conduct simple and advanced experiments in combinational and sequential logic circuits Using III and IV generation ICs. for training and simulating industrial designs

ADVANCED AND EFFORTLESS

For quicker, neat and efficient breadboarding of digital logic gates to develop, build and test complex systems before constructing prototypes

Using 24 numbers of 16 pin dual in-line IC sockets and a 22 pin edge connector for solderless interconnections and disconnections
Also can be used as Dynamic Digital Integrated Circuit tester under actual operating conditions

COMPLETELY SELF-CONTAINED

* Contains everything needed to assemble, test the logic circuits
* Built in input signals and output indicators, such as power supplies, clock signals, pulsers, logic status indicating lights, logic switches and digital displays
* Eliminates cumbersome and maze of component boxes, separate power supplies, pulse generators etc

A MUST FOR EVERY ADVANCED ELECTRONICS LABORATORY ENGAGED IN TRAINING AND DEVELOPMENT OF DIGITAL CIRCUITS

MODEL DSD-4

Similar to DSD 3 except that it has
* 16 Nos of 16 pin Dip Sockets
* 4 Nos of 24-pin MSI/DIP Sockets

SUBRA & RAM A 2

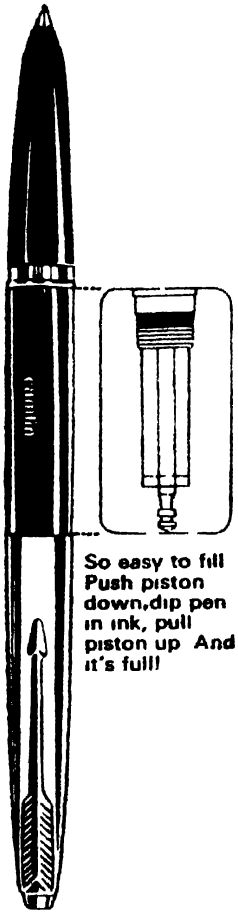
For further particulars, please contact

ALLIED ELECTRONICS MFG. CO.
337, Thambu Chetty Street, Post Box No 203
MADRAS 600 001 Phone 422269/445904/423368

new

UNMATCHED
camlin
PISTON PENS

No time wasted No messing up with ink Camlin Piston Pen mechanisms make it just easy Fill up and feel the difference

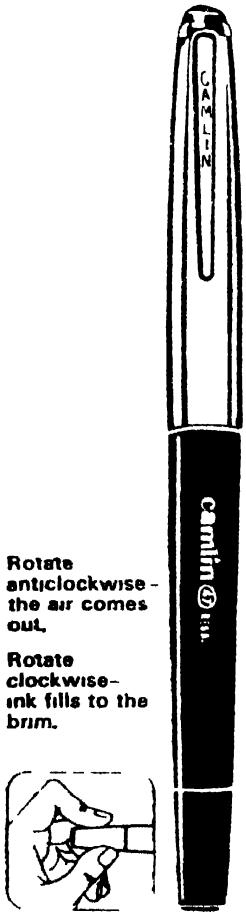


So easy to fill Push piston down,dip pen in ink, pull piston up And it's full!

INJECTION PISTON PEN 48

Rotate anticlockwise - the air comes out.

Rotate clockwise - ink fills to the brim.



PISTON FILLING PEN 47

S 793

A simple, solid-state muscle stimulator

IN ELECTROTHERAPY muscle stimulators are used to apply low frequency current pulses to stimulate muscle contractions. They help to build up the strength of weak muscles. Proper application can tone up the desired muscle or group of muscles, but an accurate knowledge of the location of 'motor points' on the body is necessary to use the faradic current most effectively as a muscle stimulant. The contraction rate must preferably lie between 30 and 70 per minute. The recommended dosage levels of these pulses by physicians are: Current: Minimum intensity, 2 milliamps, Maximum intensity, 90 milliamps. Duration: Faradism, 0.1 to 1 millisecond, Galvanism, 100 to 2000 milliseconds.

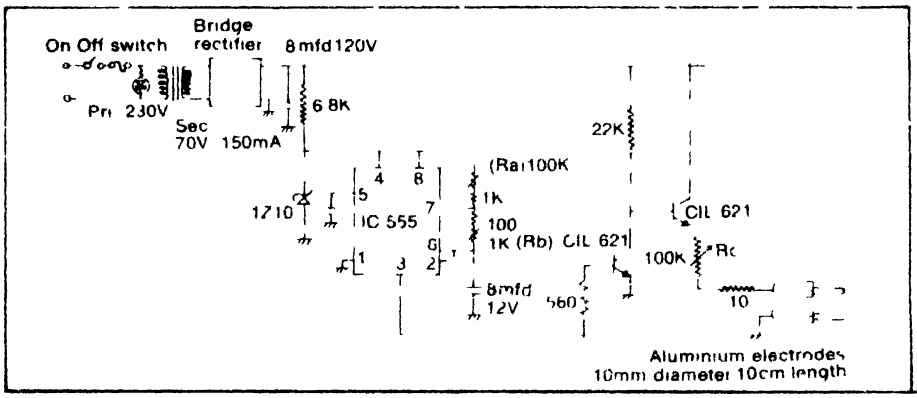
However, the kind of stimulator presently used has a number of drawbacks. Most of the commercially available units use electromagnetic relays which may give very high dosages of current of uncontrollable duration. This may be very sedative if proper relays and other precautions are not taken into account. Unfortunately replacements for those relays are not easily available. In addition these relays are very noisy. Semiconductor units available are costly and the circuit diagrams, for repairing, are not available.

In view of this I describe below a fully solid-state muscle stimulator which can give faradic current pulses of definite duration and selected periodicity quite reliably.

The device uses an integrated circuit (IC555) and two high voltage transistors. The integrated circuit is used an an oscillator to give rectangular pulses. One of the transistors is used to amplify the voltage signal and the other is used as a power stage to get pulses of definite intensity.

The 'on' and 'off' time of IC555 are governed by Ra, Rb and C. The 'off' time represents faradic current pulse duration while "on" time represents galvanic current. For a fixed value of C = 8 mfd, the calculated Ra and Rb have to be 100K (maximum) and 1K(maximum) ohms for the desired period. The power supply for IC555 is zener regulated. The secondary voltage of the transformer is rectified to get high voltage DC power supply. The device can give a peak pulse of 90 V, which is more than sufficient to stimulate buttock muscles. The output is taken through two aluminium electrodes with wooden handles. In short, Rc controls the intensity of pulses, Ra varies the galvanic pulse duration while Rb sets the faradic pulse duration.

The approximate cost of all the electronic components involved would be around Rs. 50 at current prices. The circuit diagram (shown alongside) is very simple. The components used are— semiconductors IC555, transistors, VIL 621, capacitor: 8 microfarads, 12V and 8 microfarads, 120V; resistors (half watt), 10, 110, 560 and 22K; potentiometer (1 W): 100k linear and 1K linear, transformer: primary 230V AC, secondary 70V, 150 milliamps AC.



S BIRLASEKARAN

Mr Birlasekaran is with the Central Electrochemical Research Institute, Karaikudi.

Changing chainwheels raise pedalling efficiency

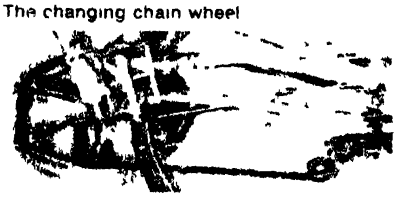
VARIOUS attempts have been made to optimise bicycle pedal power; one of these uses a linear rather than circular path for pedal motion (SCIENCE TODAY, February 1974, p. 52). *New Scientist* (**86**, 1207, p. 398) reports an automatic transmission system for bicycles designed by Michael Deal, a lecturer in engineering at the University of Bath, UK.

Climbing a hill, spurts of acceleration, overcoming high friction surfaces, all need high torque. The most natural reaction of a rider to such a situation is to pedal harder, that is, to put more pressure on the pedals. The design makes use of this very natural reaction of the rider. When pedal pressure increases, the design lowers the ratio and increases the torque.

The device uses a chainwheel whose effective size changes in response to pedal pressure. The bicycle chain passes over six small sprockets spaced around the chainwheel. These sprockets are allowed to slide in radial slots. The radial distance of the sprockets along the slot determines the effective chainwheel diameter. This diameter can vary from 250 mm to 125 mm in Deal's design. The sprockets still have to move together. A disc with individual spiral slots into which the sprocket spindles can fit takes care of this problem. The sliding of one sprocket causes the others to slide to the same extent.

The ratio changes only in a 60 degree sector just below the horizontal. The sprockets in the wheel are of two kinds— two of them are non-rotary and four are rotary. The two non-rotary sprockets have a locking function. The rotary sprockets rotate at a controlled rate. A small pinion wheel behind each of them meshes with a rack alongside the slot. The pinions determine the rate at which the free rotary sprockets rotate. So long as any of the two non rotary sprockets are in the chain a short length of the chain is kept taut. The two non-rotary sprockets perform the function of locking the chain diameter and the ratio at a particular value. It is only when the two sprockets with the locking function are clear of the chain that the sprockets are free to respond to pedal pressure.

The changing chain wheel

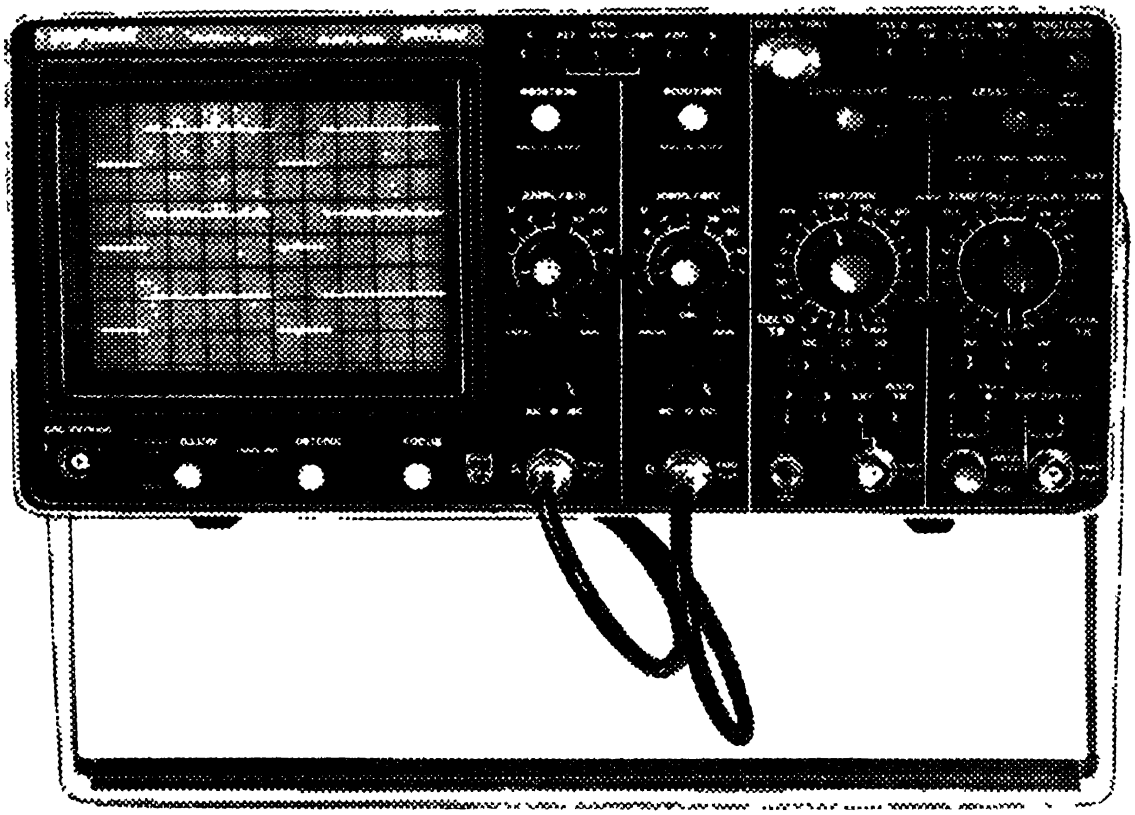


The sprocket just ahead of the pedal crank position has a half-diameter pinion. So this pinion wheel rotates twice as fast against its rack. This faster movement allows it to take up most of the chain slack as the effective chainwheel diameter decreases. A spring loaded tensioner near the back-wheel takes care of the final slack.

Deal claims that no intermittent losses in force and momentum are involved in shifting from one ratio to another. Because there are no offset sprockets chain alignment is better and frictional losses smaller. The most important advantage is the almost continual adjustment of chainwheel diameter to effort and a near-optimum pedalling efficiency under all kinds of cycling conditions.

P V P

What is a third channel doing in a dual trace 100 MHz scope?



The third channel in the new Philips 100 MHz dual trace oscilloscope helps you to see your trigger signal or any other appropriate signal

Besides the *trigger view*, the PM 3262 also offers *alternate time base*—in which a display of complete MTB and DTB, independent on the delay line, gives more information on the signals, thus helps you 'see what you do'!

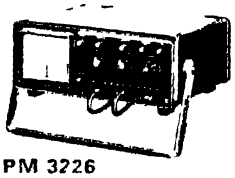
Matchless, all-round performance

The PM 3262 is the first and the only 100 MHz oscilloscope, with Trigger View and other unique features, manufactured in India

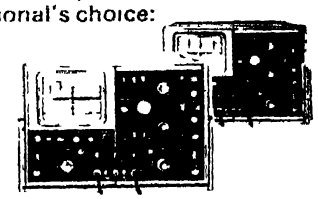
With a 3 5 ns rise time, the PM 3262 remains matchless for the most sensitive needs of a laboratory with features such as:

- 2 mV/35 MHz, 5 mV/100 MHz
- Composite triggering
- Trigger hold off
- Not triggered indicator
- Trace separator
- TTL compatible Z modulation
- 45 W power consumption
- Compact, 9 6 kg weight
- Designed to meet IEC 348 specifications and to withstand strenuous environmental conditions

The other Philips oscilloscopes to complete the professional's choice:



PM 3226
15 MHz 2mV dual-trace oscilloscope with TV triggering facility



PP 9015
Large screen 50 MHz/2mV dual-trace oscilloscope with fully calibrated delayed time-base.

PP 9016
Large screen 50 MHz/2mV dual trace oscilloscope with fully calibrated delayed time-base and a unique analog multiplication feature.

PE-SI-4869

PHILIPS

Philips in Professional Electronics

PHILIPS

Peico Electronics & Electricals Ltd

Stepping on the fishermen's toes

INDIA'S 6500-km-long coastline is studded with over 2000 fishing villages and an equal number of landing centres. Using country-boats and catamarans, the community of 6.5 million traditional (artisanal) fishermen have been contributing 70 per cent of the country's total fish catch. But today they are facing an acute economic crisis.

The reason: indiscriminate and reckless fishing by mechanised fishing trawlers and purseine boats in shallow coastal waters. And thereby also hangs a tale of how a modern technology, mindlessly used, has crushed a traditional occupation, and is destroying the entire ecosystem of the coastal waters, which is the "nursery" for the teeming fish population. Consequently, fish resources are fast depleting.

Traditionally, the coastal marine fisheries have been exploited by indigenous craft such as catamarans, dug-out canoes, plank-built boats and beach-seine boats. There are about 192,000 such boats in the marine fishing sector — 60,000 catamarans, 75,000 dug-out canoes, 35,000 plank-built boats, 9,200 beach-seine boats and 13,000 other types. For the sake of classification, we shall call these fishermen traditional, or "non-mechanised"

To assist these traditional fishermen to get a better harvest by extending their fishing area, mechanisation of fishing craft was encouraged by the government since the First Five-Year Plan. Now there are 16,500 "mechanised fishing vessels" engaged in "trawling" for prawn and "purseining" for pelagic varieties of fish like mackerels, pomfrets and sardines. These mechanised fishing vessels, owned by about 8,000 persons, a large percentage of them non-fishermen, account for 30 per cent of the total annual fish catch in India and give direct and indirect employment to nearly 165,000 persons.

While efforts were being made to "modernise" the fishing industry, the necessity to go in for deep-sea fishing to ensure the maximum exploitation of fishery resources was also felt. The emphasis on deep-sea fishing gained further momentum with the declaration of the 320-km Exclusive Economic Zone (EEZ). At present, the commercial deep-sea fishing fleet consists of nearly 200 vessels and is supposed to double in number by 1982-83.

But the 25 years of Indo-Norwegian trawler aid has brought economic distress to the traditional fishermen because of the misuse of this technology. For, instead of going outwards into deeper waters, the mechanised boats turn inwards to shallow waters and fish in the area that is essentially within the reach of human labour.

The relentless fishing in shallow waters by mechanised trawlers and purseines has destroyed the delicate fish ecology, killing fish eggs and depleting fish resources alarmingly Consequently, there is a disastrous decline in the traditional fishermen's daily fish catch, forcing them to keep their fishing tools unutilised, rendering lakhs of fishing people under-employed, unemployed and impoverished. This, together with the cutting of their nets (see later), has resulted in violent clashes in the last two years, causing over 60 deaths and thousands of arrests of protesting fishermen demanding their fundamental right to pursue in peace their labour-intensive occupation

How do modern mechanised trawlers affect the ecology in the shallow waters? The shallow coastal waters of India, along with the connecting network of rivers, estuaries and the intermediate backwaters, form a vast ecosystem. These are the nurseries of India's fish resources. This ecosystem includes the water-edge plant growth, sea weed, the warmer, nutrient-rich tidal waters, and the soft clayey mud sediments which throb with benthic life which is food for the fish and which encourages biological productivity. Fish life is fond of the warm shallow waters, and they swarm, both in the larvae stage and in the adult stage, to the muddy waters and go further upstream into the brackish river waters. Fish eggs are laid in the soft mud and on the coastal edges, and grow into larvae; some larvae float into this zone from the deeper waters and breed in this vast ecosystem for quick growth until they attain a particular size before returning to the deep sea. The large reproduction of small fish in the shallow waters attracts bigger fish from the deep sea. And this biological interaction creates a vast population of big and small fish in the shallow waters. This forms the central core of the fish ecosystem of the shallow waters. It is, therefore, imperative to control all man-made activity in this shallow-water fish-reproductive zone and also in the approaches to this zone. Any disturbance or destruction of this delicate ecology ultimately reflects in depletion of fish stock, drastic decline of fish catch and ecological imbalances.

Table 1. Total marine fish landings

Year	Quantity (tonnes)
1970	10,85,607
1971	11,61,389
1972	9,80,049
1973	12,20,240
1974	12,17,797
1975	14,22,693
1976	13,52,855
1977	12,59,782
1978	14,03,607
1979	12,12,082 *

* Approximate figure.

Source: Central Marine Fisheries Research Institute, Cochin, *Marine Fisheries Information Series, Technical and Extension Series* (No. 3, 1979).

The traditional methods of fishing by rampons, shore-seines, gill nets, cast nets, drift nets and hooks and lines are gentle and low in intensity. Trawling, on the other hand, is conducted by dragging heavy weights and beams on the sea-bed in order to squeeze the prawns out of the sea-bed. This process of dragging has a ploughing effect on the sea-bed in which the fish eggs and larvae breeding in the soft sediments are killed. Since the shallow water is a "nursery" teeming with millions of under-size fish, these also get entangled in the trawl and are killed by disturbance and abrasion. The constant, repeated dragging in the same areas finally kills even the benthic life, sea weeds, and other vegetation in the sea-bed on which the fish feed and which also serve to purify sea water by renewing the oxygen content. The dragging of weights also stirs the sediments, turning the water turbid which, together with the noise, deflects and drives away new fish shoals coming into the coast from the deeper waters for feeding and spawning. Intense and continuous criss-crossing of dragging operations, carried on day and night, by a large number of trawlers, ultimately kills all the life in the sea-bed, giving it no time for natural biological regeneration. The same results follow purseining which is meant to tap pelagic fish resources.

Such indiscriminate and reckless use of trawlers and purseiners without scientific conservation management has caused the decline of the edible crab, sea shell food, prawns, mackerels, sardines and other varieties in India (see Tables 1 and 2). After several decades of reckless trawler fishing, resulting in a drastic decline of fish catch, the world's leading fishing nations like Norway, Iceland, Peru and Britain have imposed drastic measures to regulate fishing methods, netmesh size, fishing effort and catch. The European Common Market

Choose the pimple cream that not only treats pimples but helps prevent pimple scars



ESKAMEL*

pimple cream

ESKAMEL

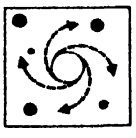
FOR THE TREATMENT OF PIMPLES AND ACNE

ESKAMEL*



The pimple cream doctors recommend

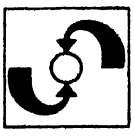
If you are not careful pimples can leave behind unsightly scars You can help by not touching pimples (even if you re itching to!) And by using Eskamel—the pimple cream that treats pimples and helps prevent pimple scars



Hands off! Pimples spread if pricked scratched or touched



Apply Eskamel over your face with damp cotton wool



Eskamel has two proven ingredients that check infection reduce skin oiliness and dry up pimples fast.

SK&F A Smith Kline & French product

*Eskamel is a Regd Trade Mark

LINTAS ESK 2 2518

nations impose strict quotas on their member countries and the Organisation for Economic Co-operation and Development (OECD)countries have banned techniques such as purseining which are stunningly overefficient but highly depletive. Norway has banned trawling and fish factories in some zones. In fact, after years of intensive mechanisation, there is now a trend back to softer, smaller scale fishing technology From 1979 onwards, Norway has banned the construction of new trawlers and has drawn up a programme of sinking a quota of existing trawlers every year. Vessels are shifting to passive methods of gill-netting and long-lining In 1980, 30 trawlers have been sunk

By 1975, having destroyed the marine resources of their own high seas and after the Peruvian fishing collapse, the developed countries unilaterally pushed the marine boundaries of their exclusive economic rights from 12 nautical miles to 200 nautical miles, and rushed in with armed naval vessels to conserve their fish wealth against international deep-sea trawler intrusion Since 1975, these richer nations have also been rushing into the less exploited regions like the Indian Ocean under the cover of "joint ventures" and "co-operative fishing ventures," but, in fact, they are plundering our seas in order to feed their own fishing industries

In this new strategy to further the interest of the developed countries into the Indian Ocean, the international aid agencies are adopting a subtle role They provide the funds and the know-how for fishing surveys and high capital-intensive infrastructural facilities like fishing harbours, boat-building yards and processing facilities. A string of fishing harbours are under construction around the Indian coast Scores of United Nations Food and Agricultural Organisation experts, World Bank and foreign trawler delegates are flooding New Delhi extolling the virtues of deep-sea trawling. They are manipulating technocrats, planners and politicians to leave our seas open to international depredation, to accept this highly sophisticated fishing technology which will eventually cripple our fish ecology, deplete our seas of its fish wealth, and rob our undernourished masses of the cheapest source of protein food The fish scooped out will go to feed pig, cattle and chicken farms in the developed nations, which, in turn, will feed the already overfed consumers there.

The pelagic fishery surveys conducted by the FAO for the last five years off the south-west coast of India have also indicated poor, sparse shoals in the Indian Ocean due to the presence of pockets of low oxygen and the absence of upwelling currents. Currently accepted fish resource estimates of Indian waters place the annual sustainable yield at 4 5 million tonnes, of which about 50 per cent lies in shallow and inshore waters up to a depth of 50 metres, 40 per cent in the depth zone 50 to 200 metres, and the rest 10 per cent beyond 200 metres deep Half of our entire fish wealth thus lies in the shallow and inshore waters up to a depth of 50 metres This zone extends to an average distance of 20 to 25 km from the shore

Table 2. Total mackerel, sardine (oil sardines-cum-lesser sardines) and shrimp (penaeid and non-penaeid prawn) landings during 1970-79 (in tonnes)

Year	Mackerel	Sardine	Shrimp
1970	1,39,206	2,82,217	1,21,691
1971	2,04,575	2,70,544	1,48,843
1972	1,08,971	1,88,850	1 63,849
1973	79,423	2,52,918	2,03,469
1974	37,462	2,10,597	1,70,178
1975	45,947	2,71,357	2,20,751
1976	65,497	2,69,262	1,91,427
1977	62,136	2,15,854	1,70,464
1978	85,233	2,20,916	1,79,856
1979	NA	NA	1,75,800

During 1971-78 the maritime states of Kerala Karnataka Goa and Maharashtra introduced 250 purseiners to boost mackerel and sardine catch From the table it is seen that mackerel landings in 1978 formed only 42 per cent of the highest catch recorded in 1971 when there were only a handful of purseiners The sardine catch in 1978 was 85 per cent of the highest recorded in 1970 And despite increase in the number of shrimp-catching trawlers to over 16 000 and their intense activity prawn yields have got fixed around 180 000 tonnes The rich prawn grounds off Kerala Karnataka Andhra Pradesh Gujarat Pondicherry and Goa are already showing signs of being overfished

Source Central Marine Fisheries Research Institute *Marine Fisheries Information Series Technical and Extension Series* (No 9 1979)

The current annual yield data highlight the fact that as much as 70 per cent of the available sustainable yield in the shallow waters and the inshore zone up to 50 metres depth is already being exploited by our traditional coastal fishing people This is an excellent performance by any standards of efficiency. Any new additional mechanised fishing effort can, therefore, be justified only if it is applied strictly beyond the 50-metre depth zone, that is, beyond 50 km from the Indian coast This is where the Taiwanese, Korean, Soviet, Japanese and Thai pirate trawlers are now fishing with open defiance while Indian trawlers are fishing in shallow waters, robbing fish shoals from our own fishermen.

According to the Central Marine Fisheries Research Institute, Cochin, Kerala, the 6.5 million traditional fishing community contributes 60 per cent of the marine export earnings and 0 5 per cent of the country's gross national product. Can India's fisheries development plans totally ignore this sector? Yet, our technocrats today talk about financial credit for expanding fishing fleet, improvement of handling, storage, processing and marketing facilities, massive extension of developed technology, providing quality fish and fish products like fish cutlets to consumers, joint ventures from foreign firms and charter of foreign vessels to boost deep-sea fishing Nothing is being spoken about the human beings for whose benefit planning is done, nothing about the 6 5 million coastal fishing people who are a national resource waiting to be utilised to achieve the plan targets, and nothing about the human tragedy they face today It appears that India's fisheries planning philosophy consists of just blindly importing sophisticated mechanised technology.

What the traditional fishermen need today is a new technology which will raise their standard of living. But the new technology must mesh into their existing economic condition and then raise it to a higher economic standard Any plan of 'modernisation must have three attributes. First, the technology should not harm the ecology Second, it must raise the productivity of the existing labour-intensive units without displacing labour Third, it must raise the standard of the entire mass of people without concentrating resources in a minority at the expense of the majority that is, modernisation must be income-distributive The appropriate technology should, therefore, be basically cheap, simple, continue to employ millions of fishermen and yet efficient

This could be achieved in several ways (i) fit the existing fishing craft and catamarans with small outboard and inboard motors, from 3 hp to 15 hp, to reduce manual rowing time and increase fishing hours, thus raising production and extending the operational area, (ii) since both timber and craftsmen are becoming scarce, adopt moulding techniques for indigenous organic fibres and resins to produce cheap, light and simple craft; (iii) develop a new technology to preserve the catch on board to extend fishing time (can we not produce cheap, cold storage units working on kerosene for use on boats or on the beach?), (iv) a new technology (probably based on solar energy) for drying fish cleanly and then packing them neatly for mass consumption, and (v) a cheap radio communication system for fishermen who face the hazards of the sea and are often totally lost

CHRISTOPHER FONSECA, MATANHY SALDANHA URBAN LOBO

Mr Fonseca is executive member and Mr Saldanha chairman of the National Forum for Catamaran and Country-boat Fishermen s Rights and Marine Wealth, Cansaulim, Salcete, Goa Mr Lobo is a chartered civil and hydraulic engineer



But when you're fighting stubborn and severe dandruff you need a shampoo even stronger than Clinic.



NEW

CLINIC SPECIAL

We know that you are happy with Clinic; it has worked on your dandruff But we also know that there are some people whose dandruff is stubborn and severe. That's why we have introduced a new formulation that helps clear stubborn and severe dandruff. Even more effectively than Clinic It's Clinic Special.

So now there are two Clinics

Clinic for normal dandruff. And Clinic Special for stubborn and severe dandruff. Together they are the answer to all dandruff problems.

A quality product by HINDUSTAN LEVER LIMITED

HLCS-5041

(Our April 1980 issue carried a write-up by Mr. H. D. Gupta about an interesting property of prime numbers he had come across and verified for all primes up to 103. It said that if p is a prime number (other than 2, 3 or 5) and if we write down a number with p-1 digits with all digits equal to one, then this number is divisible by p

The write-up has provoked a large response from the readers. One reader reported extending the verification to all primes up to 43207 on a computer. All the other letters point out that the result follows directly from Fermat's theorem. Mr. H. D. Gupta has also sent in a letter pointing this out. Dr B V Limaye comments below on Fermat's theorem and some related interesting properties.

In the same issue we also carried a write-up, by Jayashree S., on numbers capable of being expressed as the sum of two squares. Mr Vivek S Kale points out an exception and goes on to prove and generalise the result.)

Dividing by prime numbers

FERMAT'S theorem says that if p is a prime and b is an integer, having no common factor with p, then p divides $b^{p-1}-1$.

Mr H D Gupta's problem follows from the special case of this theorem when b = 10. If b = 10, then $b^{p-1} - 1$ can be seen to be a number with p-1 digits all equal to nine. So, Mr Gupta's number is $(10^{p-1} - 1)/(10-1)$. According to Fermat's theorem if p is a prime having no common factor with 10, (so that p cannot be 2 or 5) p will divide $10^{p-1} - 1$. Since to get Mr Gupta's number we divide $10^{p-1} - 1$ by nine, p need not divide Mr Gupta's number when p has a common factor with nine, (or when p is 3). Thus, we can see that except for 2, 3 and 5, any other prime p will divide the number with p–1 digits all equal to one, which is the exact statement of Mr Gupta's problem.

The value of a number with p-1 digits all equal to one depends on the base of the number system that we use. In our normal decimal system the base is 10 (or 9+1). It may be interesting to know whether the result still holds if we change the base of the number system from 10 to any other integer b. In view of Fermat's theorem, Mr Gupta's number expressed in a number system with *any* integer b as its base will still be divisible by p so long as p does not divide either b or b–1.

It is natural to wonder what would happen if we consider any positive integer instead of the prime number p in the above discussion. In this general case, one would seek for a generalisation of Fermat's theorem. Such a result was proved by Euler and is as follows.

Let $\phi(m)$ denote the number of positive integers less than m having no common factor with it. For example, if m equals 12, then there are only four numbers less than 12 having no common factors with 12, namely 1, 5, 7 and 11. Euler's result states that if a positive integer b has no common factor with m, m divides $b^{\phi(m)} - 1$. If m equals a prime number p, then none of the positive integers less than p has a common factor with p so that $\phi(p)$ equals (p-1) and we obtain Fermat's Theorem.

In this light, Mr Gupta's problem can be generalised as follows. Given a positive integer m which is not divisible by 2, 3 or 5, write down a number with $\phi(m)$ digits all equal to 1. Then this number is divisible by m. For instance, if m equals 77, then it can be verified that $\phi(m)$ equals 60. Thus, if we consider the number 11 ... 11 where the ones occur 60 times, then 77 divides this number. Incidentally, 77 is the smallest non-prime that can satisfy Euler's theorem with b equal to ten, the base of the decimal system.

Divisibility by prime numbers reminds us of a curious result due to Wilson. It states that every prime p divides the number $1 \cdot 2 \cdot 3 \cdots (p-3) \cdot (p-2) \cdot (p-1) + 1 = (p-1)! + 1$. What is more, the converse of this statement is also true. That is, if n is a positive integer which divides $(n-1)!+1$, then n must necessarily be a prime number!

The theorems of Fermat, Euler and Wilson involve the concept of multiplication of integers, modulo a given integer m. The proofs may be found in the classic "An Introduction to the Theory of Numbers" by G H Hardy and E M Wright, Oxford University Press, at pages 63 and 68.

B V LIMAYE

Dr Limaye is Assistant Professor at the Department of Mathematics, Indian Institute of Technology, Bombay.

Sum of squares

IN "Products of Squares" (SCIENCE TODAY, April 1980, page 63) Jayashree S observes that the product of two numbers, each of which is a sum of two squares and which do not have a common factor, can be expressed as a sum of two squares in two different ways. This is not quite true, as in the case of 40 (8x5). Here $8 = 2^2 + 2^2$ and $5 = 2^2 + 1^2$ and have no common factors. Yet 40 can be expressed in only one way as the sum of two squares, namely $(6^2 + 2^2)$. The necessary result can be proved and generalised as follows:

Let X be equal to the sum of the squares, say $(a^2 + b^2)$, and let Y be a similar number equal to $(c^2 + d^2)$ where all the numbers involved are positive integers. Then the number

$$X \times Y \quad (a^2 + b^2)(c^2 + d^2)$$
$$= (ac)^2 + (cd)^2 + (bc)^2 + (bd)^2$$
$$= (ac)^2 + (bd)^2 + 2abcd$$
$$- 2abcd + (ad)^2 + (bc)^2$$

So that

$$(X \times Y) = (ac + bd)^2 + (ad - bc)^2 \quad .. \text{ A}$$

$$\text{or } (ac - bd)^2 + (ad + bc)^2 \quad .. \text{ B}$$

This is the result that Jayashree S. arrives at. But, if in the above result we have c = d, then the two expressions A and B will become equivalent. Thus, if in Jayashree S.'s problem, any of the number X or Y has the form of $2c^2$ where c is an integer, then $(X \times Y)$ can be expressed as a sum of two squares in only *one* way. This happens for the example of $(8 \times 5) = 40$, because $8 = 2 \times 2^2$.

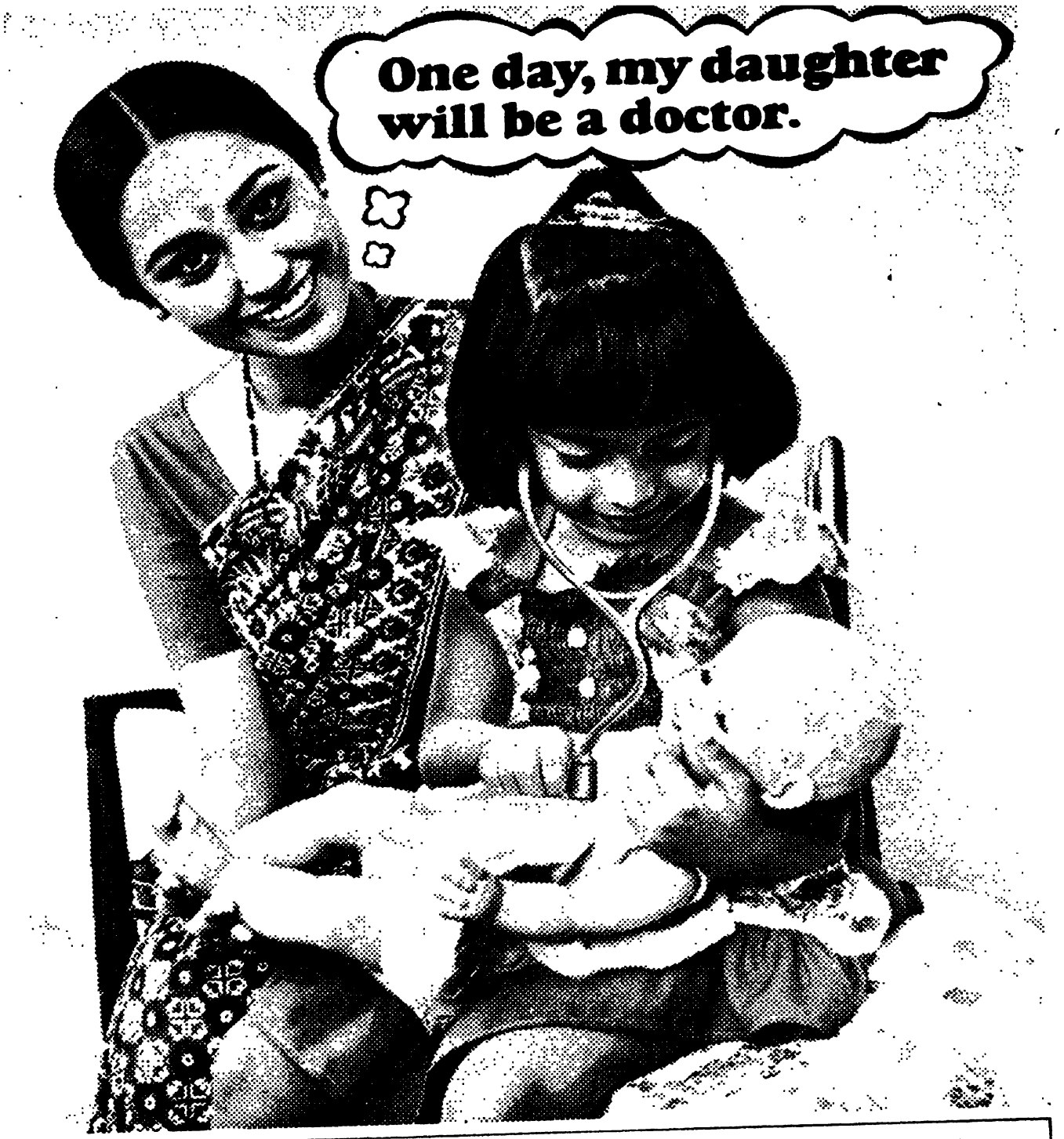
Jayshree S.'s problem may then be generalised for the product of n such numbers. The statement of this would read as follows:

If $X_1, X_2, X_3 \ldots X_n$ are n numbers, each of which can be expressed as the sum of two integral squares in a unique manner and if further, $X_1, X_2 \times X_3 \ldots X_n$ have no common factor with one another, then the product of these n numbers $(X_1 \times X_2 \times X_3 \ldots X_n)$ can be expressed as the sum of n squares in not more than 2^{n-1} ways.

The proof of this statement can easily be achieved inductively. There is an interesting application of this result to analytic geometry. The relation $x^2 + y^2 = (a^2 + b^2)$ is the equation of a circle with centre at the origin and a radius $\sqrt{X}$. Similarly, $x^2 + y^2 = (c^2 + d^2)$ will describe a concentric circle with radius $\sqrt{Y}$. Then the result says that if two concentric circles have only one point each with integral co-ordinates, then the concentric circle with a radius equal to the product of the radii has at least one and at most two points with positive integral co-ordinates. In the case of n such concentric circles, the concentric circle with a radius equal to the product of all the radii has at least one and at most 2^{n-1} points having positive integral co-ordinates. This relation also has application in vector analysis, matrices and other areas.

V S KALE

Mr Kale is a post-graduate student at the Department of Geology, University of Poona.



Let that one day start today. Step into State Bank right away.

A child's bright future is every parent's dream. What every parent doesn't dream of is how fast time flies and how soon tomorrow comes. Too often our dreams are shattered because of lack of foresight and planning.

At State Bank we have a scheme for every one, for every dream. Choose from the Reinvestment Plan, Recurring Deposit Scheme, Savings Account, Term Deposit, Janata Deposit, Minor's Account and the Perennial Pension Plan.

Save with
State Bank
India's largest bank.

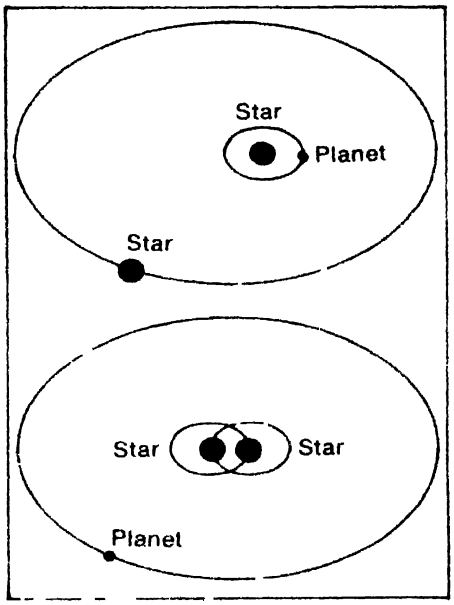
CHAITRA-SBI-628

...the sun had a companion!

OUR SUN is a single star with no companion, so we believe—though astronomers have often speculated that there may be a very distant and very faint companion to the sun But there is no evidence, observational or otherwise, for it It is well known that the planet Jupiter perhaps narrowly missed being a star In the universe, binary stars are far more numerous than we think An examination of the stars closest to our solar system shows that of the 47 stars within 17 light-years 14, that is about 30 per cent, are multiple systems, with at least one of them being a triple system Of course these figures do not include any of the dark companions too faint to be seen This figure of 30 per cent continues to hold even for distant star systems, though optimistic estimates suggest that most stars are associated with a multiple system of one form or the other So it would not be an idle speculation to imagine what it would be like for the solar system if the sun were a binary star

A binary star is a system made of two stars bound together by mutual gravitational attraction and orbiting round each other about a point in space known as their centre of mass There are two general types of binaries— the very close or spectroscopic binaries with periods measured in days and the wide binaries with periods measured in years Needless to say there are systems with higher multiplicities containing three or more stars but they are relatively rare In this article we shall only consider binary star systems The important question is whether planets can exist around binary stars We shall leave open the difficult and still unsolved problem about the possible initial formation of a planetary system round a binary, but take the more tractable problem of finding conditions to be satisfied by a planet orbiting round a solar type binary star to be able to support life as we know it on the earth It is possible that certain other species of life may exist and thrive in conditions very different than those existing on the earth, but we shall restrict our discussion to the terrestrial-type life

The first condition is that the planetary orbit round a binary star must be stable By stability we mean that the basic parameters characterising the size and shape of the orbit do not change greatly over long periods of time Another condition is that the planetary orbits should be nearly circular if the planet is to sustain life The condition for supporting life is that there should not be large variations in the distance from the primary source of energy over the course of one revolution Hence, we look for the existence of regions around a binary star in which the planetary orbits do not change size or depart significantly from the circular shape Still another very important question from the point of view of supporting terrestrial-type life is whether the region of stability is also the region known as the 'zone of habitability" This is the region in which the total amount of energy received from the stars in the binary system is just right for the formation and sustenance of life This will



Two types of planetary orbits are possible in a system of two stars bound together by mutual gravitational force The top figure shows a planet close to one of the stars whereas the one below shows the planet at a distance from the stellar binary

depend on the distance from the star system, the brightness and the temperature of the stars forming the binary Summing up we can say that for a binary star to be suitable for a habitable planet it must have a zone of stable planetary orbits which would include the region which we called the zone of habitability This is the region in which the total energy received by the planet should be the same as that received by the earth from the sun

We shall now consider the problem of determining whether binary stars can have regions in which planetary orbits are stable and what their limitations are This determination requires the solution of a problem which is known in classical celestial mechanics as the three-body problem, because a planet revolving in an orbit round a binary star involves three bodies This problem has not been solved so far by analytical methods The problem of a planet revolving round a single star can be easily solved, leading to Kepler's laws, but no such simple solution exists for a three body problem However, it is possible to find a solution of the three body problem to a high degree of approximation, using modern high-speed computers One can handle stability problems by following the motion within a specific system long enough to determine whether the system is indeed stable and repeating this process for a large number of specific cases Such computer experiments despite their limitations, have been carried out for the case of a planet in a binary system

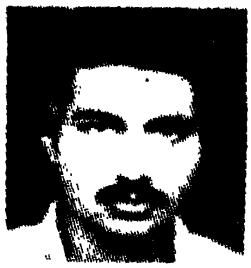
Two general classes of stable planetary orbits are thereby obtained The first case is that of a planet orbiting close to one of the stars while the other star in the binary is revolving at a large distance from the first The second example is that of a planet revolving in an orbit at a large distance from the two stars forming a close binary These computer experiments have yielded the following information about the extent of the region of stability For the first case planetary orbit is table as long as the distant star never gets nearer than approximately three and a-half times the distance of the planet from the close star In the second example, the orbit of the planet is stable as long as the planet is outside approximately three and a half times the mean separation of the stars in the binary Thus the regions of stability are quite extensive If the planet travelling along a stable orbit round a binary system is to be able to support life the region of stability should overlap the zone of habitability

We are now in a position to offer some information about the fate of the planets in the solar system if the sun had a companion The computer experiments mentioned above can be applied to the solar system and one can see what would happen if it were suddenly to turn into a binary system with the sun having a companion As stated earlier, Jupiter could have been a star—it is actually called a failed star so let us suppose that in the place of Jupiter there were a star as massive and bright as the sun Actually Jupiter will have to be at least 65 times as heavy as it is now to become a star capable of sustaining a heat source of thermonuclear origin within itself Of the inner planets, Mars would get perturbed very quickly and start wandering erratically, ultimately resulting in its expulsion from the system Saturn's orbit will also be severely perturbed If what we have said above about the stability region is right, then the earth's orbit should be stable since Jupiter's mean distance of 5 2 AU (AU stands for Astronomical Unit which is the mean distance of the earth from the sun) is more than 3 5 times the earth's distance from the sun Earth's orbit may slightly vary from what it is at present, but the variation in distance will be small There will be no significant change in the temperature and other physical conditions

MEDICAL ENTRANCE



Sunil Kumar Bansal
1st in Medical Entrance Delhi '77



Raghavendra Goswami
1st in Medical Entrance Wardha '77



Bhupinder Bhandari
1st in Medical Entrance Delhi '78



Rajiv Verma
2nd in Medical Entrance Delhi '78

THESE TOPPERS WERE OUR STUDENTS

And to crown it, while In 1977 out of the 35 students selected by the prestigious ALL INDIA INSTITUTE OF MEDICAL SCIENCES, as many as 16 were our students, in 1978 out of the 25 students selected by the same A.I.I.M.S., as many as 11 happen to be our students.

NEED WE SAY ANYTHING MORE ABOUT OUR RESULTS?

You too, have an opportunity to secure a position in these tests.

RESULTS OF I. I. T. ENTRANCE EQUALLY BRILLIANT

ENSURE YOUR SUCCESS THROUGH OUR COMPREHENSIVE

CORRESPONDENCE COURSE

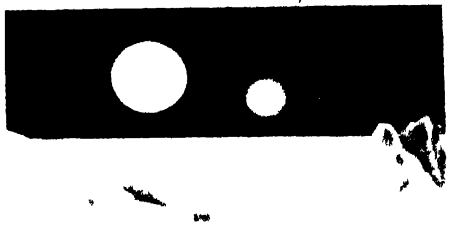
ALSO PERSONAL TUITION CLASSES FOR I.I.T. AND MEDICAL ENTRANCE
HOSTEL FACILITIES EXIST

SACHDEVA NEW P. T. COLLEGE

29-T PATEL NAGAR, NEW DELHI-110008
32-T NEHRU PLACE, NEW DELHI-110019

on the earth. The "other" sun would appear star-like, but much bigger and brighter than all other stars in the sky during the night In fact, it would beat the full moon in brightness, though it would appear smaller in size When the two suns are in the same constellation, the other sun would not appear in the night sky, unlike the moon Whenever it appeared in the night sky it would send an eerie light on the earth, much brighter than moonlight, more like twilight During this part of the year, it could never get dark at night with dawn and twilight merging into its light The amount of energy that we shall receive from this 'other" sun will only be one-sixteenth of what we now receive from our sun

For the second case, let us replace the sun by a close binary with a pair of sun like stars having a mean distance of 0 2 AU Such a binary would have a revolving period of just under 33 days In this case Mercury, whose average distance from the suns would be about 0 38 AU is immediately thrown out of the system Venus (distance 0.72 AU), though stable, would show some variation in its present orbit Even in this case, earth's orbit would be stable, as its distance from the binary is nearly five times the mean binary separation The earth s orbit will vary only slightly from its present position It can be easily seen that the earth will be a much hotter place than now, as two suns instead of one will shine on us from almost the same distance! If the distance between the suns in the binary were to exceed 0 28 AU, we will be in trouble on both counts—stability and temperature



Another attractive possibility is the existence of a binary component of our sun at the distance of Pluto which has a mean value of about 40 AU from the sun If this binary is not sun-like but a seventh magnitude red dwarf, then one can make intelligent guesses about how it would be like in this system Such an example exists in ETA Cassiopeia The stars in this binary system would orbit around each other with a period of about 500 years From the earth, the secondary, the other sun would appear as an orange point of light brighter than the full-moon Due to its long period it would appear relatively stationary in the sky especially when it is farthest moving hardly at all (half a solar diameter per year) For much of its 500 year period it would be a fixture in the sky casting enough light to produce a faint orange twilight glow at night

It would be interesting to speculate about the possible modes of evolution of the animal and human species on the earth under the conditions of the binary sun . Perhaps the biological origin and evolution of species would not be much different than what it is now, but it is likely that the progress of civilisation, culture and science could have taken a completely different turn in the presence of the other sun Particularly the science of astronomy would have progressed much less beyond the observation of these suns as the dark sky, so vital for the observations of starry systems beyond the solar system, would be a rarity Perhaps radio astronomy could have had a big edge over the optical wavelength astronomy In the absence of visual evidence, it is interesting to speculate how radio astronomers (would these be the only kind of astronomers apart from solar astronomers?) would interpret their data Particularly, objects like quasars or quasi stellar objects (QSOs), without their star-like appearance, being observed would have, in all likelihood, received completely different interpretations

R V KAMAT

Prof Kamat is with St Xavier s College, Bombay

Awards and Appointments

Dr. S.K. Jain

Dr. S K Jain, director of the Botanical Survey of India, has been awarded the National Environment Fellowship for 1980. Under the Fellowship, Dr Jain will study the status and conservation of rare and useful flora of the country

ICSSR Chairman

MR. G. PARTHASARATHY, former vice-chancellor of Jawaharlal Nehru University, has been appointed chairman of the Indian Council of Social Sciences Research.

CWC Chairman

MR. R. GHOSH has taken over as chairman of the Central Water Commission under the Union Ministry of Irrigation.

Advisory Committee for Space Sciences

The Chairman, Indian Space Research Organisation (ISRO) has set up an Advisory Committee for Space Sciences (ADCOS) in India. ADCOS will advise ISRO on various aspects of space research contemplated in the future, especially those involving active support from ISRO The following are members of ADCOS Prof R R Daniel, Tata Institute of Fundamental Research, Bombay (Chairman), Prof M K V Bappu, Indian Institute of Astrophysics, Bangalore, Dr P M Bhargava, Regional Research Laboratory, Hyderabad, Prof M K. Dasgupta, Institute of Radio Physics and Electronics, Calcutta, Dr K Kasturirangan, ISRO Satellite Centre, Bangalore; Prof. D Lal, Physical Research Laboratory, Ahmedabad, Dr. P.J. Lavakare, Department of Science and Technology; Dr A P Mitra, National Physical Research Laboratory, New Delhi, Prof R Narasimha, Indian Institute of Science, Bangalore, Prof. V Radhakrishnan, Raman Research Institute, Bangalore; Dr S Ramaseshan, Indian Institute of Science; Dr S Ramnath, Vikram Sarabhai Space Centre, Trivandrum; Prof. B. R Rao, University Grants Commission, New Delhi, Prof U. R. Rao, ISRO Satellite Centre, Bangalore, Dr. M.K Tiwari, ISRO (HQ) is the non-member secretary.

Indian Joins AEA

DR. SYED FAREEDUDDIN has joined the Atomic Energy Agency in Vienna as Director of the Nuclear Safety and Environmental Protection Division. He was acting Director of the Bhabha Atomic Research Centre, Bombay, for 15 months and was closely connected with the building of heavy water plants and also reprocessing of uranium elements.

Brain Teaser

DISTRIBUTION OF MONEY I distributed some one rupee notes unequally between my two daughters The elder told the younger If I subtract your amount from the square of mine the result is 158 and if I subtract my amount from the square of yours, the result is 108 How much did each of them get?

V A SHENAI

(Solution next month)

Solution to last month's Brain teaser

Let the numberss be a and b Obviously a–b = 10 and ab = 2475 Factorising, 2475 = 11 x 9 x 5 x 5 An inspection of these factors shows that the required numbers are 11 x 5 and 9 x 5, that is, 55 and 45

This may also be solved by another method

$$\text{Now } (a+b)^2 = (a-b)^2 + 4ab$$
$$= 10^2 + 4 \times 2475$$
$$= 10{,}000$$
$$a + b = 100$$
$$a + b = 10$$

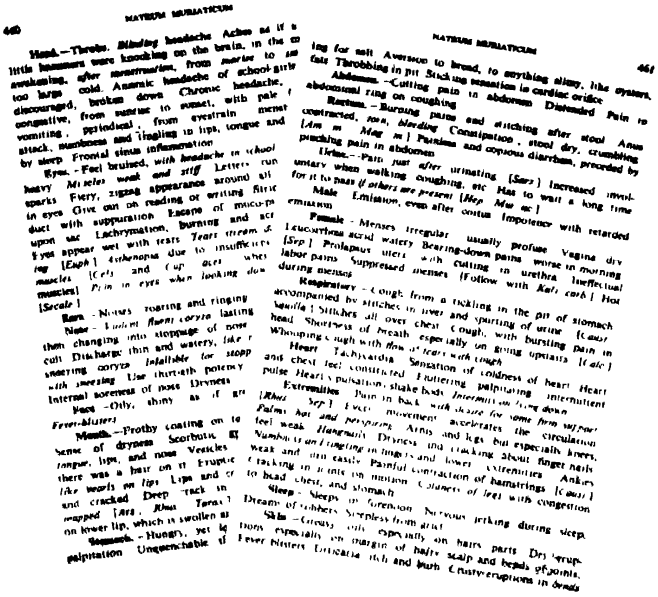
Solving, a = 55 and b = 45

Science does not claim to provide immediate answers to every question that can be asked at any given time

For example:



A scientist can say, without any feeling of guilt or shame, "I do not know"
What science considers undesirable is not the lack of knowledge but the lack of curiosity and of the desire to learn.
What goes entirely against science is the acceptance of answers that are incompatible with knowledge acquired through the method of science.
For example, the homeopathic drug, Natrum Mur, is claimed to cure, amongst many others, the following ailments:



NATRUM MURIATICUM

Head.—Throbs. *Blinding* headache. Aches as if a little hammers were knocking on the brain, in the occiput, awakening, after menstruation, from *exercise* to an overheating, after menstruation, from *exercise* to an too large cold. Anaemic headache of school-girls discouraged, broken down. Chronic headache, congestive, from sunrise to sunset, with pale vomiting, periodical, from overstrain. menstrual attack. numbness and tingling in lips, tongue and by sleep. Frontal sinus inflammation.

Eyes.—Feel bruised, with headache in school sparks. Fiery, zigzag appearances around all heavy. *Muscles* weak and *stiff*. Letters run in eyes. Give out on reading or writing. Stitching duct with suppuration. Burning and sore upon use. Lachrymation. Escape of mucus. Eyes appear wet with tears. *Tears stream* ing. [*Euph.*] Amblyopia due to insufficient muscles. [*Cycl.*] and *Cup.* also when muscles. *Pain* in eyes when looking down. [*Secale.*]

Ears.—Noises roaring and ringing. Noise.—Loudest *fluent coryza* lasting them changing into stoppage of nose. cold. Discharge thin and watery, like sneezing coryza *infallible* for stopp with sneezing. Use thirty-sixth potency. Internal soreness of nose. Dryness.

Face.—Pale, shiny as if an *Fever-blisters.*

Mouth.—Frothy coating on to sense of dryness. Scorbutus. tongue, lips, and nose. Vesicles there was a hair on it. Eruptive like *warts on lips.* Lips and cr and cracked. Deep rack in mapped. [*Ars., Rhus, Teucr.*] on lower lip, which is swollen as Stomach.—Hungry, yet lo palpitation. Unquenchable t

NATRUM MURIATICUM

ing for salt. Aversion to bread, to anything slimy, like oysters, fats. Throbbing in pit. Sticking sensation in cardiac orifice. Abdomen.—Cutting pain in abdomen. Distended. Pain in abdominal ring on coughing. Abdomen. Distended. Pain in

Rectum.—Burning pains and stitching after stool. Anus constricted, *sore, bleeding.* Constipation, stool dry, crumbling. [*Am. m., Mag. m.*] Painless and copious diarrhoea, preceded by pinching pain in abdomen.

Urine.—Pain just after urinating. [*Sars.*] Increased involuntary when walking, coughing, etc. Has to wait a long time for it to pass *if others are present.* [*Hep., Mur. ac.*]

Male.—Emission, even after coitus. Impotence with retarded emission.

Female.—Menses irregular, usually profuse. Vagina dry. Leucorrhoea acrid, watery. Bearing-down pains, worse in morning. [*Sep.*] Prolapsus uteri, with cutting in urethra. Ineffectual labor pains. Suppressed menses. [Follow with *Kali. carb.*] Hot during menses.

Respiratory.—Cough: from a tickling in the pit of stomach accompanied by stitches in liver and spurting of urine. [*Caust.*] *Sawfile.*] Stitches all over chest. Cough, with bursting pain in head. Shortness of breath, especially on going upstairs. [*Calc.*] Whooping cough with flow of tears. *with cough.*

Heart.—Tachycardia. Sensation of coldness of heart. Heart and chest feel constricted. Fluttering, palpitating, intermittent pulse. Heart's pulsations shake body. *Intermits on lying down.* [*Rhus. Sep.*]

Extremities.—Pain in back, *with desire for some firm support. Palms* hot and perspiring. Movement accelerates the circulation, feel weak. *Hangnail.* Dryness and cracking about finger nails. Numbness and tingling in fingers and lower extremities. Ankles weak and turn easily. Painful contraction of hamstrings. [*Caust.*] Cracking in joints on motion. Calluses on hands. Blisters of feet with congestion to head, chest, and stomach.

Sleep.—Sleepy in forenoon. Nervous jerking during sleep. Dreams of robbers. Sleepless from grief.

Skin.—Greasy, oily, especially on hairy parts. Dry eruptions especially on margin of hairy scalp and beads, gf joints. Fever blisters. Urticaria, itch and burn. Crusty eruptions in bends

Pages from Pocket Manual of Homeopathic Materia Medicia *by William Boericke, MD*

I don't know

We do not as yet know how our brain stores, puts together and recalls information

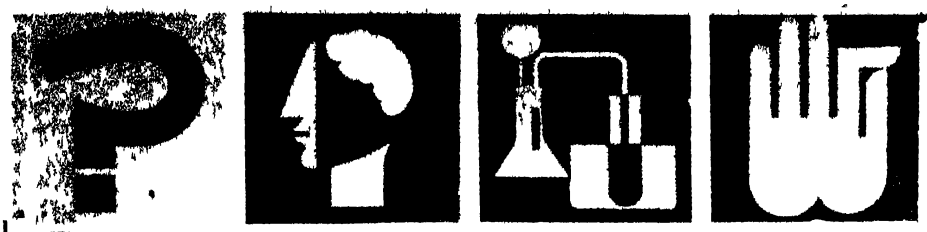
To obtain the curative effects listed at left, the recommended dose would probably not exceed 24 pills (of strength called "6x") per day.
Each Natrum Mur pill would have, as its active ingredient, 0 1 millionths of a gram of the chemical, sodium chloride, that is, common salt. Therefore, the maximum amount of common salt an individual may receive through the Natrum Mur pills will be 2.4 millionths of a gram per day.

Now let us look at some facts of science·

- ★ We take in through our food five to 20 grams of common salt every day
- ★ We, therefore, receive 20 to 80 hundred thousand times more salt through our food every day than we would through the pills.
- ★ The salt we take in through our food is in no way distinguishable from the salt we would receive through the pills.
- ★ Therefore, the extremely small amount of extra salt received through the pills cannot make a difference to our body.

In other words, if we accept science, we must conclude that the pills of Natrum Mur cannot cure the ailments they are claimed to cure.
If any cure can be scientifically demonstrated, it must be due to causes other than the pills of Natrum Mur. One such cause, for example, could be "psychosomatic", which can be tested experimentally by giving plain sugar pills instead of the Natrum Mur pills without, of course, the patient knowing that he is receiving a "placebo".
Obviously, the claim that Natrum Mur can cure the ailments or diseases mentioned at left, has not been arrived at by using the method of science.

Design Feroze Chandra



The method of science

8

Text©P M Bhargava

Contrast the attributes of science described on these pages (see also SCIENCE TODAY June 1980) with the following attributes of dogmatic beliefs (a) dogmatic beliefs, including miracles are often inconsistent with known and established observations (b) a new set of dogmatic beliefs often attempts to replace fully the existing sets, and (c) a set of dogmatic beliefs once established continues substantially unchanged

The answers in science (the facts and the generalisations) are truths by agreement of opinion based on the method of science



The participants at the first Solvay Conference held at Brussels in 1911

The agreement has to be reached among people who are knowledgeable in the area concerned and who form their opinion by using the method of science The agreed opinion must be arrived at after such individuals have either verified the answer personally or satisfied themselves adequately about the validity of the experiments and of the logic which led to the particular answer

The greater the above agreement and the greater the evidence in favour of the truth (such as a fact or a law) the more rigid must be the proof or the evidence which will allow any modification or disproval of the truth to be accepted by the scientists and the lesser will be the chance that the new evidence against the truth will stand a close scrutiny by them

As time passes and the sum total of knowledge in the particular field increases the chances that the initial agreement of opinion will prove to be wrong diminish

This is the test of time in science

For example

The chances of the proposition that water on a molecular basis consists of two parts of hydrogen and one of oxygen will be proved wrong in the future must be considered extremely remote because a very large number of scientists — with probably no exception — have accepted this for centuries and have found no reason to alter their agreed opinion

On the other hand out of a very large number that has been proposed there is yet no known theory of cancer that may not easily be proved wrong in the future This is because no theory has stood the test of time on the basis of agreed opinion among experts

Corollaries

1 An important objective of scientific training should be to enable one to evaluate evidence against an answer — for example a fact or a law — arrived at through the method of science Scientific training should allow one to assess the chances of such evidence being true

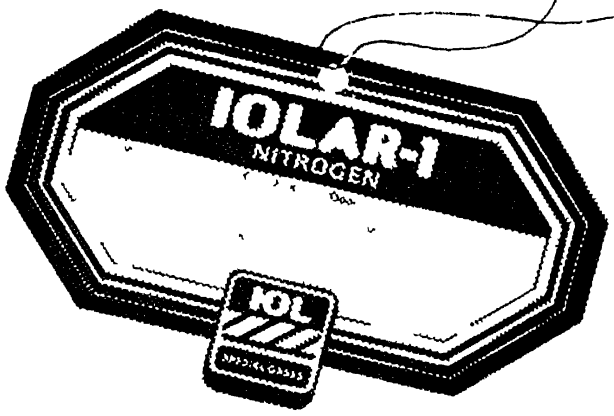
2 The method of science has a built-in-corrective The corrective is provided by (a) the right to question and (b) the requirement for a consensus that is agreement of opinion



A patient with a Burkitt s Lymphoma the only human cancer known for sure to be caused by a virus

MAKING HIGH PURITY GASES IS ONE THING...

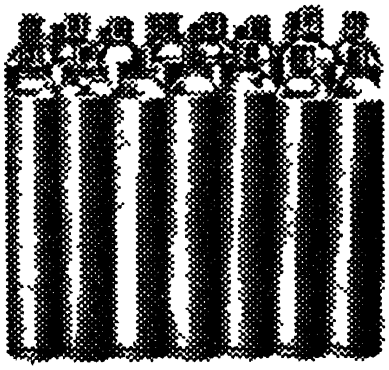
CERTIFYING THEIR IMPURITIES TO LESS THAN A MILLIONTH PART - THAT'S TECHNOLOGY !



That's the measure of Indian Oxygen s gases processing and handling technology

It takes technological vision of the highest order to perceive gases even to zero levels To define in absolute terms the miniscule impurities that are inevitable in high purity gases and liquids To prepare with the utmost precision gases and gaseous chemical mixtures of stringent specifications The labels which certify our IOLAR range of special gases testify to this technological excellence The beneficiaries ? The newer and more sophisticated industries who would otherwise have to import their requirements

IOL has ever been in the forefront of gases applications technology The innovations introduced by IOL have resulted in enormous saving of energy leading to higher productivity in



iron steel copper and chemical industries Today IOL's concern is to extend the use of gases to the priority areas of food preservation and transportation, environmental control and recycling of industrial wastes

IOL s leadership in all its operations is the leadership of technology Cross fertilising the latest innovation with existing knowledge to breed a new generation of products and services For progress

IOL Indian Oxygen Limited

IOL offers the best in technology

IOX CAS 4/80

Emergency light

This is a fully solid-state emergency light. It does not have an electromagnetic relay or component which mechanically changes the contacts. It switches on the lamp when the mains power supply goes off. The circuit shown here is for a 12-volt battery.

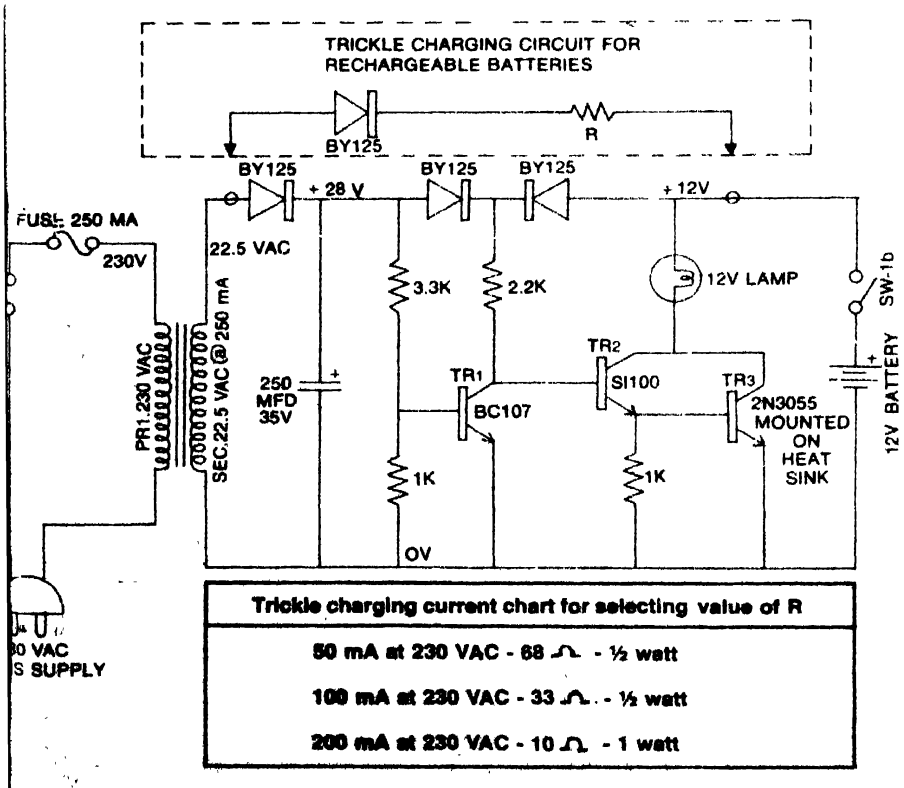
The device is a fully solid-state voltage-sensitive switching system. The normal voltage provided by the 250 mfd filter capacitor from the 230 V AC mains supply by step-down transformer-rectifier-filter circuit is about 28 V DC. This voltage is fed through a 3.3K/1K voltage divider to the input of transistor Tr1. This keeps the transistor Tr1 in saturated condition. As the input of the Darlington pair configuration of transistors Tr2 and Tr3 is connected across the collector-emitter of transistor Tr1, the transistor Tr1 in saturated condition, keeps the Darlington pair input shorted. When the mains supply fails, the voltage across the filter capacitor drops to zero. This cannot keep the transistor Tr1 in saturated condition. This drives sufficient input current, through 2.2K, the collector resistor of Tr1, to the input of the Darlington pair. This brings the Darlington pair in saturation. As the output of the Darlington pair is connected to operate through the lamp to the battery, the lamp lights up and remains lighted till the mains supply comes back. The use of three transistors in the device provides the snap action and thus reduces overheating of transistor 2N3055 when used to drive high wattage lamps.

When using this emergency light with a 6 volt battery, all you have to do is to use a lamp of 6 volts instead of 12 volts.

The transistor 2N3055, used in the circuit, can easily handle lamps requiring currents up to 5 amps when the transistor is mounted on a suitable heat-sink of copper or aluminium sheet of area about 100 sq cm. It is the battery which has to provide the current. A current of this order can be supplied only by rechargeable batteries normally used in cars and motor cycles. Ordinary torchlight dry cells, connected in series, to provide the required battery voltage, can be used with lamps requiring current up to 0.3 amp. This application with low wattage lamps requires no heat-sink for transistor 2N3055.

A two-pole ON/OFF switch is used to disconnect the mains as well as the battery when the unit is not required in operation.

If you want to use the device with a rechargeable battery, then a simple trickle charging circuit can be added. The chart shows the selection of resistor R for different trickle charging currents to suit different types of batteries. The trickle charging keeps the battery in "full form" without overcharging.



Trickle charging current chart for selecting value of R
50 mA at 230 VAC - 68 Ω - ½ watt
100 mA at 230 VAC - 33 Ω - ½ watt
200 mA at 230 VAC - 10 Ω - 1 watt

Trickle charging: To maintain rechargeable batteries used on standby services at full charge, they can be trickle charged. Trickle charging consists in maintaining a constant charging current through the battery; the charging current is calculated to be slightly more than the self-discharging current of the battery. If too high a rate is used, excessive gassing will result and frequent watering of the battery will be necessary. If the current is too low, the battery will gradually lose its charge.

Note: The device explained above is the modified version of "Solid-state emergency light" (SCIENCE TODAY, April 1975).

You will need:

Semiconductors

Transistors 2N3055 - 1 No.; SL100 - 1 No., and BC107 - 1 No.

Rectifiers BY125 or BY126 or equivalent - 3 Nos.

Capacitor 250 mfd 35 volts - 1 No.

Resistors (all half-watt type): 3.3K - 1 No.; 2.2K - 1 No., and 1K - 2 Nos.

Transformer (made to order): Primary: 230V AC; Secondary: 22.5V AC at 250 mA - 1 No.

The approximate cost of the above components in the Bombay market is Rs. 60.

Misc: 2 pole ON/OFF switch - 1 No.; Battery 6 or 12 volts - 1 No.; lamp 6V or 12V (depending upon the battery used) 0.3A - 1 No.

Lamp holder, vero board or group board, wires, solder, screws, suitable enclosure, mains supply plug, 250 mA fuse with holder.

Additional components required for rechargeable battery circuit. Rectifier BY125 or BY126 or equivalent - 1 No. Resistor (as per the trickle charge chart) - 1 No.

Rechargeable battery and lamp of appropriate voltage.

ANIL V. BORKAR



"Eureka! Metre-long toilet soap, to be used according to individual mass."

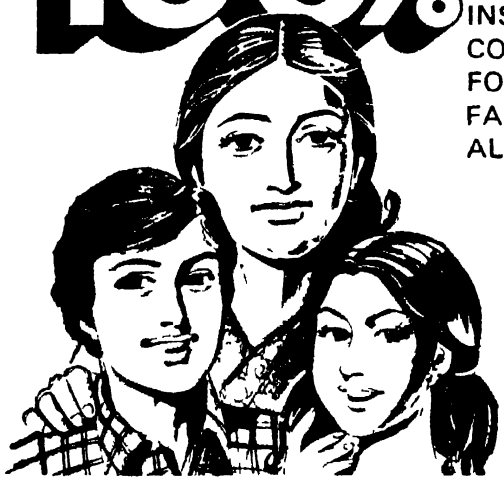
NEW!

ANTICIPATED WHOLE LIFE POLICY

50% OF INSURED AMOUNT DURING THE POLICY TERM BY INSTALMENTS.



100% INSURANCE COVERAGE FOR YOUR FAMILY AT ALL TIMES.



Attractive double-benefit plan

- Ensures 50% of the insured amount during the policy term
- Provides 100% insurance cover, available at all times even after the policy term

You can take the policy for 20 years or 25 years For instance if you take a 20-year policy at the age of 35 the Anticipated Whole Life Policy provides two distinct types of benefits - helps you meet your short term needs with the money you get back from the policy at periodic intervals over 20 years, provides complete long-range insurance protection for your family even after the obligations to pay premiums have ceased

See how a 20-year policy of Rs. 25,000 operates when a person takes the policy at the age of 35:

On survivance to 40 he gets	Rs 3 125 00
On survivance to 45 he gets	Rs 3,125 00
On survivance to 50 he gets	Rs. 3,125 00
On survivance to 55 he gets	Rs 3,125 00

Even after the policy term is over his family is entitled to the benefit of the assured amount in case of his death

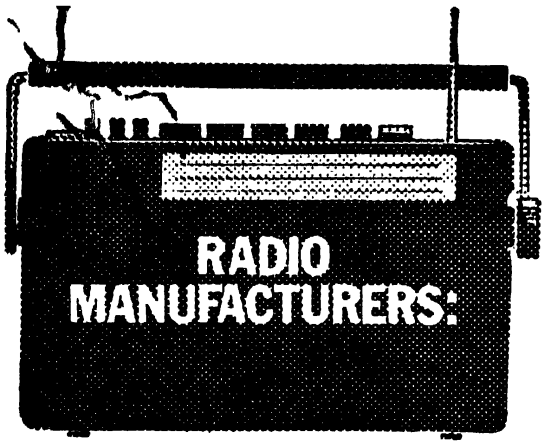
If death occurs during the policy term of 20 years or at any time thereafter, the family will get the entire insured amount with the bonuses irrespective of the number of instalments that the policyholder would have received

This unique policy brings your family double benefits. Ask for the Anticipated Whole Life Policy by name

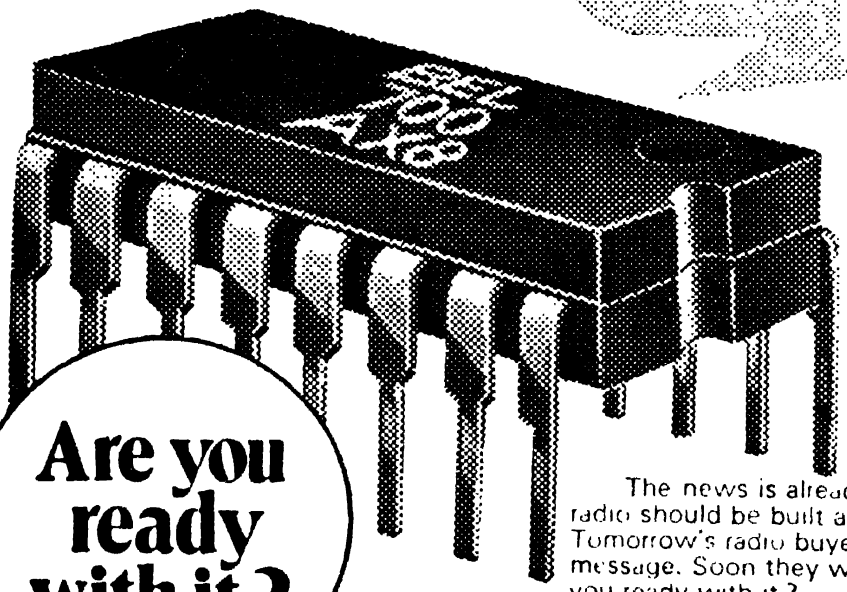
Please contact your LIC Agent or the nearest office.

Life Insurance Corporation of India

RADEUS/LIC/SP-37



From tomorrow buyers are going to demand the radio of the future



Are you ready with it?

The news is already broadcast that the most advanced radio should be built around the latest BEL IC technology. Tomorrow's radio buyers have tuned in and got this message. Soon they will be looking for the IC radio. Are you ready with it?

If you have second thoughts, just listen to us.

Radios built with ICs offer these additional advantages:

- High sensitivity is maintained even when the battery voltage drops.
- Built-in stabilisation circuit is provided.
- Circuit is protected in case of short circuit of output terminals.
- Miniaturisation with maximum advantage.
- Rugged and hardy in use.
- Comparable performance at competitive prices.

If you thought solid state was a revolution, IC radio is way ahead the world over.

Tune in to the demanding consumers' voice. Get ready with your IC radio. Ask BEL what they can do to make your brand of IC radio a listening pleasure.

Ask BEL about IC radio circuitry and BEL-700 IC

BEL–leaders in professional electronics

Write to : Chief Sales Manager (Components),
BEL, Jalahalli, Bangalore-560 013

BHARAT ELECTRONICS LTD.
(A Government of India Enterprise)
Bangalore • Ghaziabad • Pune

CAS-BEL-8048



PNB has shown me how to earn extra income every month

With my growing expenses, I was finding it difficult to make both ends meet So, I deposited my bonus in PNB's **Special Fixed Deposit**

Now I get a regular amount as interest every month With this amount I am able to pay for a few things I need

Rs 30,000 deposited for 63 months will fetch the depositor Rs 247 92 every month as interest The principal remains intact

You can deposit a minimum of Rs 500/

Interest for 12/36 months deposit 7% p a

Interest for 39/60 months deposit 8 5% p a

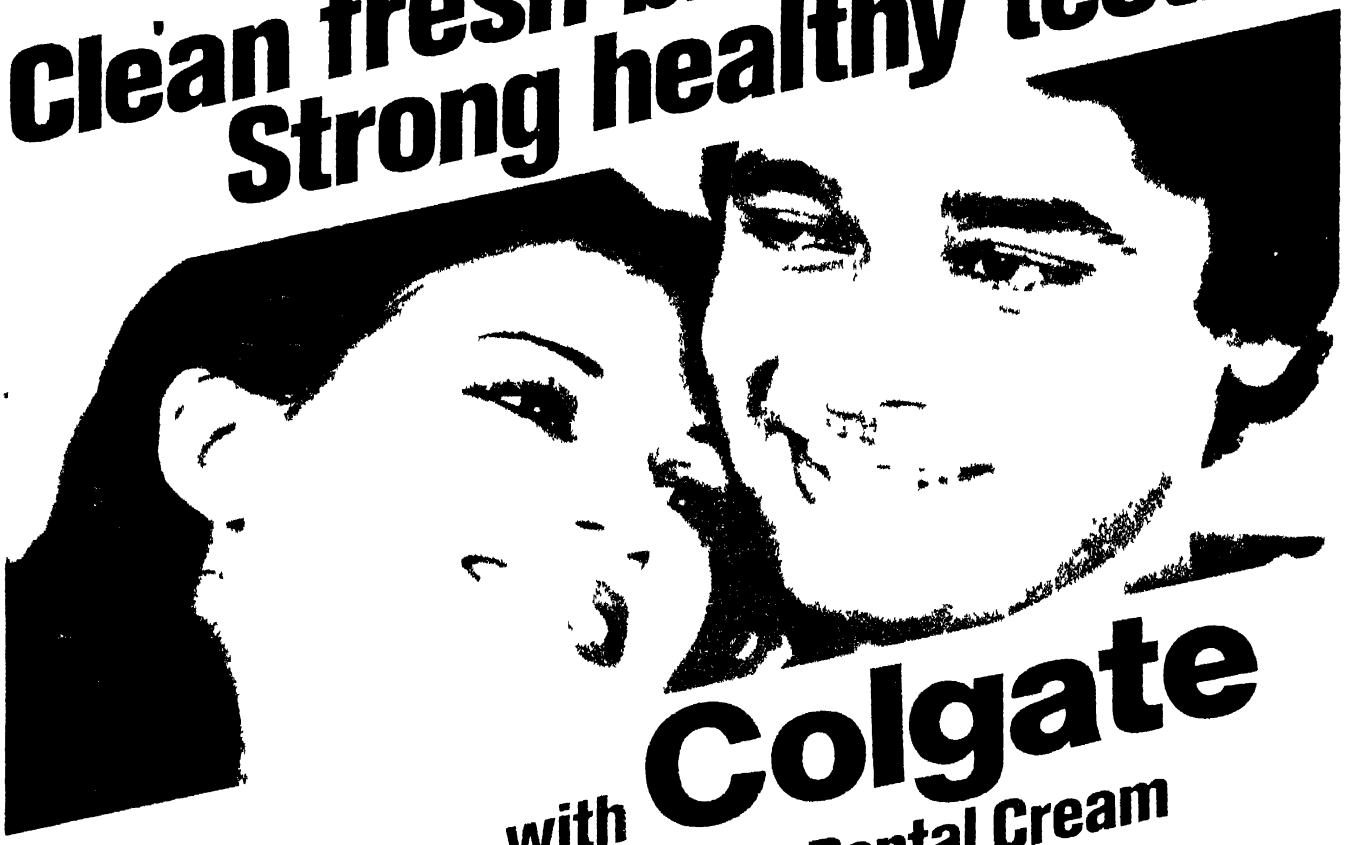
Interest for 63/120 months deposit 10% p a

punjab national bank

(A Government of India Undertaking)

the name you can BANK upon !

Clean fresh breath... Strong healthy teeth



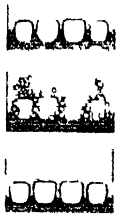
with Colgate Dental Cream

Brush your teeth with Colgate after every meal. It protects your teeth the way dentists recommend all over the world.

Bacteria grow in food particles left between your teeth. These can cause bad odour and, later, painful decay.

So always brush the Colgate way right after eating. It's proven most effective to freshen your breath, whiten your teeth and fight decay.

How Colgate's trusted formula works



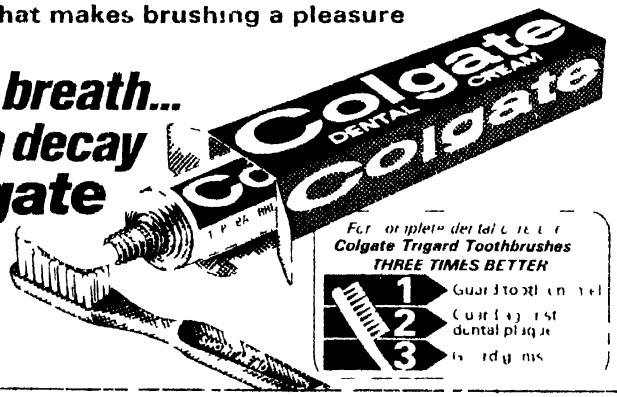
...dour and decay causing bacteria grow with food particles trapped between your teeth.

...Colgate foaming action foams reaches deep between every tight gap to flush away food particles and bacteria.

The result: attractive white teeth, fresh breath and considerable protection against decay.

Colgate has the fresh, minty taste that makes brushing a pleasure

Stop bad breath... Fight tooth decay with Colgate Dental Cream



DC G /3 80

Behind every healthy child there is an invisible touch of SARABHAI M CHEMICALS

We look after children's interest in many ways:

Our SORBITOL makes unpleasant medicines sweeter

Our MANNITOL makes chewable tablets sweeter for children

Our FINE CHEMICALS and VITAMINS enrich baby foods and makes babies fatter and healthier

Our LABORATORY REAGENTS are custodians of children's health by safeguarding quality of foods and drugs.

SARABHAI M CHEMICALS

A sweet invisible touch to children's health.



SM 1/79



Every drop of New Code 10 Tonic Hair Dressing nourishes hair, controls dandruff, gives your hair the natural look

Code 10 contains Panthenol to nourish your hair, give it vitality and bounce. And LO-7, a proven anti-dandruff ingredient, to help fight dandruff.

Whether you are a man or a woman give your hair the natural look with Code 10, every day. It does your hair a world of good—and it doesn't cost the earth.

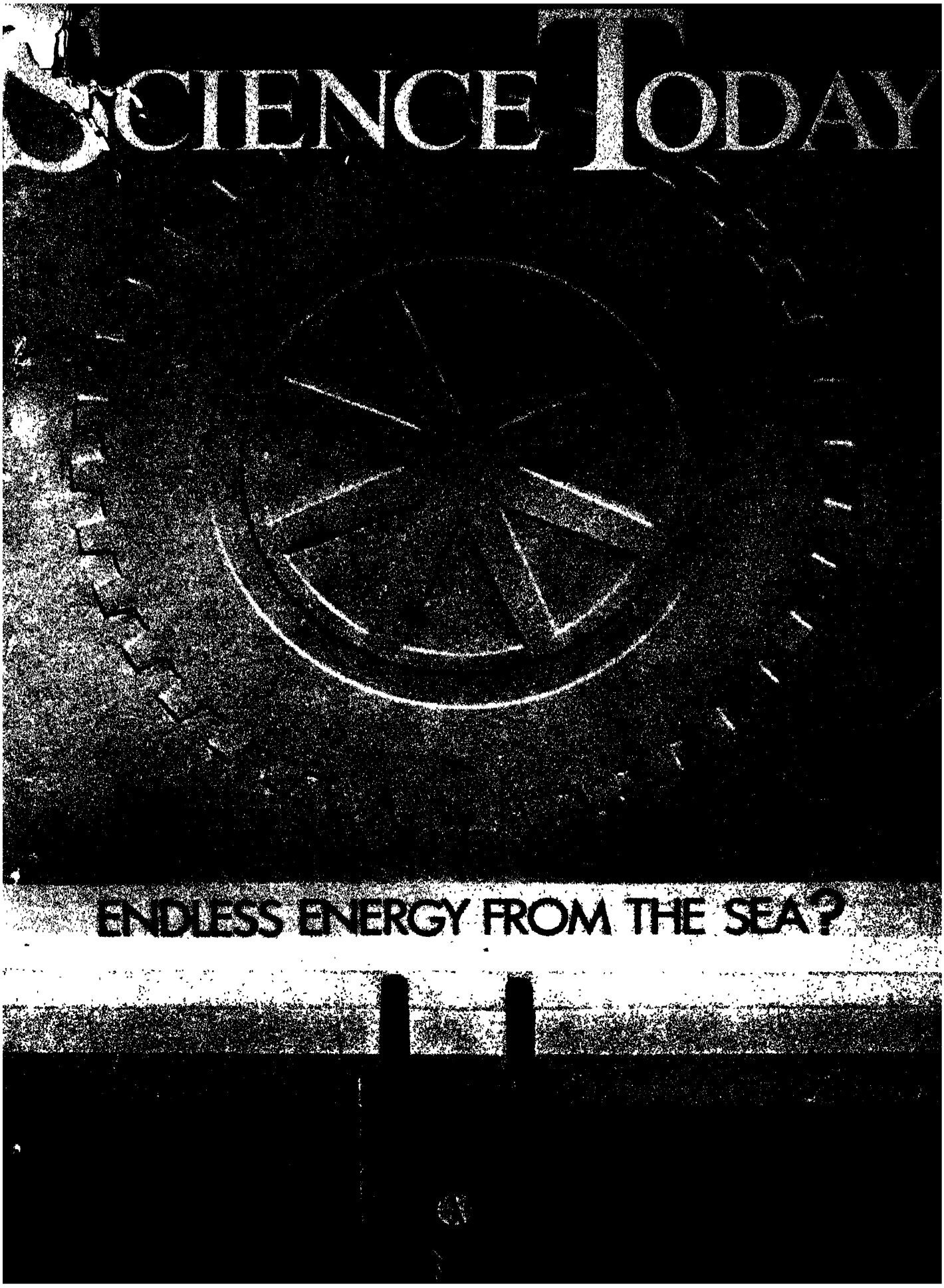


Your secret code to healthy, well-groomed hair

PC.B.3.80

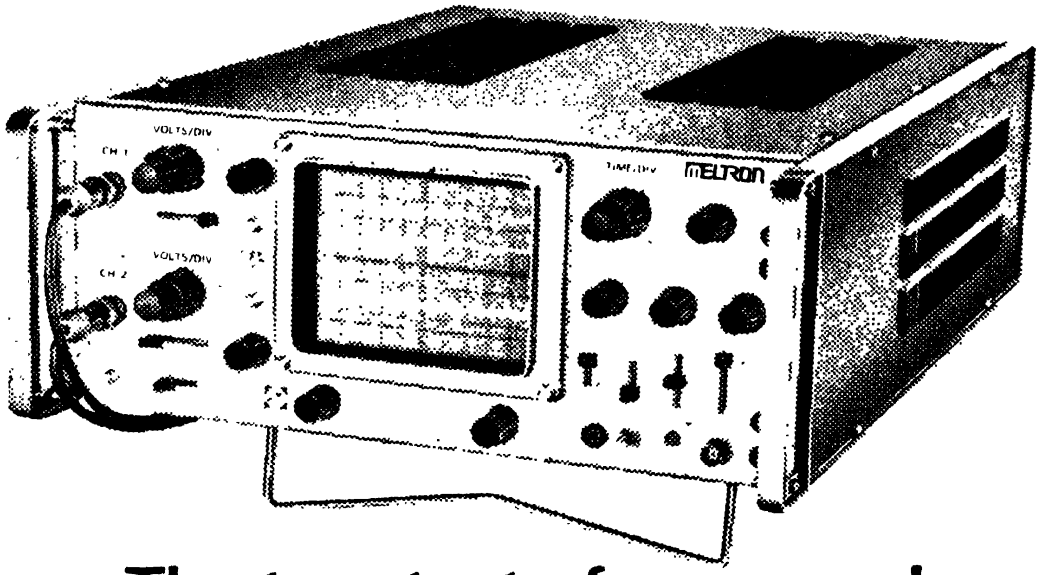

Never
sold loose
-beware of
imitations.
PARLE
Some swear it's sweet.
Others insist it's salty.
All agree it's tasty.
tasty, tasty.
everest/79/I
Krackjack

SCIENCE TODAY



ENDLESS ENERGY FROM THE SEA?

When high accuracy is essential... measure it with MELTRON OSCILLOSCOPES



The true test of accuracy!

Rugged and dependable, MELTRON all-solid state Oscilloscopes are designed for high input sensitivity. They are available in four models—single and double beam, dual trace and portable—covering bandwidths from 10 to 25 MHz. A wide range to choose from, for every possible application.

Other high-quality systems from MELTRON include:

1. Uninterrupted Power Supply System
2. Fire Alarm System
3. Digital Display System
4. Closed Circuit TV

I would like more information. Please send me your detailed folder on

- ☐ Meltron Oscilloscopes
- ☐ Meltron UPS System
- ☐ Meltron Fire Alarm System
- ☐ Meltron Digital Display System
- ☐ Meltron CCTV

(Please tick to indicate your requirement)

Name. _____

Company address _____

_____

MELTRON
Meeting the challenge of tomorrow.

Manufactured by:
International Electronics

Marketed by: Maharashtra Electronics Corporation Limited
Plot No. 214, Backbay Reclamation, Raheja Centre, 13th Floor, Nariman Point, Bombay 400021.
Tel: 240538 Telex: 011-6817 ME Cable: MELTRON
7A, Hansalaya, 15, Barakhamba Road, New Delhi 110001. Tel: 40641 Telex: 031-2815 MELN
55, Rama Nivas, 10th Cross, West of Chord Road, II Stage, Bangalore 560010. Tel: 80772.

CHAITRA-ME-96-R

"CORRESPONDENCE EDUCATION HAS THUS STOOD THE TEST OF TIME AND ESTABLISHED ITS EFFICIENCY"

said, **Shri B. D. JATTI,** the former Vice President of India,
while inaugurating the Eleventh World Conference of the International Council for Correspondence Education at New Delhi

The British Institutes is proud of its achievements in Correspondence Education :



Personal Secretary

- LARGEST CORRESPONDENCE COLLEGE IN INDIA, WITH OVER 45 YEARS' EXPERTISE.
- HELPED OVER A MILLION MEN AND WOMEN IN PLANNING THEIR CAREERS.
- CAREER ORIENTED COURSES, WRITTEN AND EDITED BY EXPERTS,

FOR

CERT. A.I.I.B., D.B.M. (I.M.C.), D.Com. Banking, D.Com. Business Org., D.Com. Accts. & I. Tax, D.Com. Comp. Sec., D.Com. Costing, C.A. Entrance, A.I.A.M., A.C.S. (India), A.M.I.E. (India), A.M.I. Mech. E. (India), A.M.I.I. Chem. E., A.M.Ae.S.I., A.S.E. (London), N.P.C. Supervisors & I.I.T. ENTRANCE EXAMINATIONS.

DIPLOMA Courses in Business Management, Industrial Mgt., Export Mgt., Personnel Mgt., Sales Mgt., Materials Mgt., Office Mgt., Business Training, Banking, Accountancy, Secretaryship, Business Letters, Personality Development, Journalism, Commercial Art, Good English, French, German, Russian, Mechanical, Electrical, Automobile, Civil, Chemical, Diesel, Radio, Transistor Radio, Television, Textiles, Rubber, Petroleum, Computer, Refrigeration and Industrial Chemistry.



Transistor Radio Engg.

We are officially recognised training centre for Cert. A.I.I.B., D.Com. (IMC) & D.B.M. (IMC) Examinations.

Tools and Kits supplied for Radio Engg. and Transistor Radio Engg. courses

Write today, send coupon, come personally or telephone 256755

THE BRITISH INSTITUTES
S6/B7. P.O.Box 1025,359,D.N.Road, Bombay 400 023

THE BRITISH INSTITUTES, S6/B7, P.O. Box 1025, 359, D. N. Road, Bombay 400 023

Please Send me a FREE Prospectus in the SUBJECT . . .

Name . Education .

Address . . .

FLUENCY IN A FOREIGN LANGUAGE CAN DO WONDERS TO YOUR CAREER



For a better job,promotion or business, knowledge of a foreign language is an added advantage.
Ofcourse, you do not have time to attend classes

That is why

LINGUAPHONE

is meant for you.

Spend 30 minutes a day to gain command over the language of your choice.
Linguaphone courses, consisting of gramophone records or cassettes and books, are available in French, German, Russian, Japanese, Spanish, Arabic, Persian, Chinese (Mandarin) Chinese (Cantonese), English, Intermediate & Advanced English, Malay or any of the 38 languages.

Write today, send coupon or come personally for Free details to :

LINGUAPHONE INSTITUTE (Dept. S6/F7)
UCO Bank Building, Flora Fountain,
359, D. N. Road, Bombay-400 023
Demonstration Centres at : 13/1A, Govt. Place East, Calcutta
13, Daryaganj, New Delhi • 35, Mount Road, Madras

LINGUAPHONE INSTITUTE S6/F7, UCO Bank Building, Flora Fountain, 359, D. N. Road, Bombay-400 023

Please Send me a FREE Prospectus for. . . . . (specify language)

Name . . . . . .

Address . . . . . .

Enjoy the pleasure of a truly creative hobby at home with an ICS–Art course

Oil Painting, Fine Art, Commercial Art, Cartooning, Water Colour Painting, Portrait Painting.

Other interesting Courses : Photography, Interior Decoration, Dressmaking, Pattern Cutting and Designing, Beauty Care and Personality, Etiquette and Entertaining, Flower Arrangement, Poultry Keeping, Gardening, Free Lance Journalism, Short Story Writing, T.V. Script Writing.

Management Practice, General Management, Marketing Mgt., Office Management, Industrial Mgt., Purchase Officer's, Storekeeping, Business Training, Cost Accountancy, Good English, Advanced English, Computer Programming, Computer Engg. Boiler Engg., Refrigeration & Air Conditioning, Electronics, Television, Transistor, Automobile Engineering



Write today, send coupon, come personally or telephone 256755

INTERNATIONAL CORRESPONDENCE SCHOOLS
S6/D7,UCO Bank Bldg.,Hutatma Chowk, P.O.Box 1931, Bombay 400 023

INTERNATIONAL CORRESPONDENCE SCHOOLS
S6/D7,UCO Bank Bldg., Hutatma Chowk, P.O. Box 1931, Bombay 400 023

Please Send me a FREE Prospectus in the SUBJECT . . .

Name . . . . . Education . . .

Address . . . . . .

NORVICSUN



We said 'WIDIA' instead.

The people who gave birth to tungsten carbide in 1926 – Krupp of West Germany, christened it WIDIA. To them it was a very precious achievement in metallurgy. This invention opened up dramatic new possibilities in metal cutting and set the pace for increased productivity levels.

In this country Widia started production in 1967 – the year that signified performance, productivity and profitability through advanced metal cutting technology.

Technology that's on call today by almost every industry, ranging from aviation to watch-making. For a very wide range of tools for all machining needs.

Technology that's updated and perfected by Widia's R&D. Providing superior tool material. Increasing tool life. Reducing tool costs and raising productivity.

Technology adapted to suit the special needs of our industry. To meet the challenges of tomorrow. A breakthrough!

WIDIA

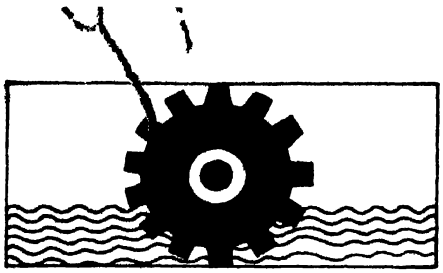
WIDIA (INDIA) LTD.

WIDIA–*leadership through technological breakthrough*

CAS-WIL-8098

Science Today

September 1980 Vol 14 No 9



17 Endless energy from the sea?
S Z Qasim

The sun s energy that is stored in the oceans may soon provide a viable solution to the world s energy problems

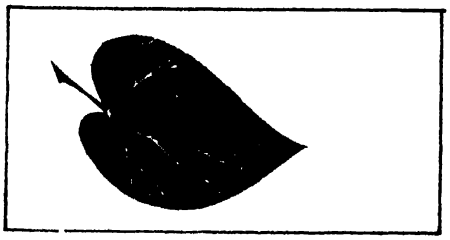


29 UNCSTD—One year after
P J Lavakare and M G K Menon

Hindsight helps to have a much sober assessment of last year s United Nations Conference on Science and Technology for Development

41 The problem of transboundary pollution
Armin Rosencranz

A nation s interest in industrial advancement may clash with its neighbours right to a clean environment



45 Post-graduate engineering education in India

The Nayudamma Review Committee has found the state of post-graduate education and research in engineering and technology unsatisfactory

51 Dog-bite madness
A N D Nanavati

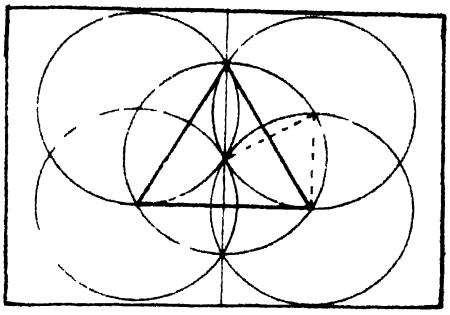
Countries which have rid themselves of rabies have done so by eliminating the carriers of this deadly disease

56 Calmodulin
Nirmala Maheshwari and Kusum Malhotra

A calcium-binding protein provides the clue to how calcium functions in the body

63 Geometry and the modern student
Dan Pedoe

A new and convincing proof that the three sides of an equilateral triangle are equal to one another



68 The method of science—9

Does science seek explanations of the supernatural and the unknown?

4 Letters
6 Viewpoints
9 Blurs and Bright Spots
13 Science Shapes Life
25 Round-up of Research
27 This World of Science!
27 and of Scientists
37 Ideas and Inventions
43 Books
55 If
59 Quiz (Aerobatics)
65 You Too Can Do It
67 Awards and Appointments

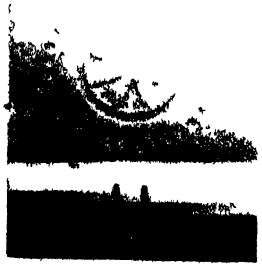
6 How relevant is PRL research?

9 Government, science and technology—twilight of the gods

55 If there was no moon...

59 How much do you know about aerobatics?

65 Low-level fuel indicator alarm



Cover, Nana Shivalkar

Ed tor
Surendi Jha

Editorial queries are to be addressed to the Editor SCIENCE TODAY Times of India Building Dr D N Road Bombay 400001 Unsolicited articles must carry adequate return postage

Single copy Rs 2
Subscription 1 year Rs 20
2 years Rs 39, 3 years Rs 58

Subscription queries and payments should be addressed to the Circulation Manager SCIENCE TODAY Times of India Building, Dr D N Road Bombay 400001

Printed and published for the proprietors Bennett Coleman & Co Ltd by T P Pithavala at Usha Offset Printers Pvt Ltd 125 Govt Industrial Estate Kandivli Bombay 400 067 General Manager Dr Ram S Tarneja Branches 7 Bahadurshah Zafar Marg New Delhi 110 002 139, Ashram Road Ahmedabad 380 009 105/7A S N Banerjee Road Calcutta 700 014 Offices at 13/1 Government Place East Calcutta 700 069, 63 Montieth Road Egmore Madras 600 008 407-1 Tirath Bhavan Quarter-gate, Pune 411 002 26 Station Approach, Sudbury Wembley Middlesex London U K London Tel 01-903-9696

SCIENTIFIC TEMPER AND PUBLIC POLICY

PROF UDGAONKAR in Viewpoints (May 1980) has raised some vital issues relating to science and public policy. Unless we resolve some of these with a sense of urgency Indian science may suffer irreparable damage.

While many of these issues are well understood there is little that the scientists and technologists seem to be prepared to do. To take an example, the BHEL-Siemens deal was raised to the political level by Mr P. Ramamurthy, MP. The press took an unusual interest and raised it to the level of *cause celebre*. However, none of the scientific organisations like the Institution of Engineers, Indian National Science Academy or the Indian Science Congress thought it an issue worth cognisance. What does this show? One possibility is apathy but more likely these organisations are controlled by persons whose self interest does not allow them to take up issues relating science with public policy, particularly when these are controversial. The vast majority of scientists and technologists and their associations continue to revolve around problems of promotions, transfers, wages and above all in keeping their associations alive in an atmosphere generally surcharged with repression and selective patronage.

Indian scientific capabilities have reached a level of maturity and given a proper linkage between industry and research institutes it is possible to develop products and systems indigenously. However, the politico-administrative structure is influenced by multinational and the World Bank (possibly with payoffs) which do not hesitate to denigrate Indian science relegating it more to the work of import substitution and turning to the west for technology. The private sector imports brand names, capital goods, know-how etc—all masquerading as technology. What then is the future of Indian science and technology?

Last year the Delhi Science Forum organised a national seminar on the Import of Technology and its Impact on Development. The participants included scientists and technologists from national laboratories, industry and universities, economists, members of Parliament, members of the Planning Commission and political workers. Implementing the following resolutions passed at the seminar would be a step in the right direction.

1. The present instruments of policy with regard to the import of technology which have in practice proved ineffective in achieving the national goal of self reliance must be thoroughly reviewed and revised.

2. Institutional arrangement be made for the professional assessment of technologies that are considered for import from the economic, social, political, energy and environmental angles.

3. The onus of proving that no indigenous technology exists in a particular field and that a specific technology needs to be imported should be on the party desirous to import the technology.



Lack of scientific temper I say! He should have let it out in a reputed journal first

4. The code of conduct for working scientists and technologists in government and elsewhere must be so devised as to enable them to disseminate information, express opinions and freely participate in discussions on all matters pertaining to science and technology. This would be in consonance with the statutes of the working scientists adopted by UNESCO, to which India is a party.

5. To prompt the utilisation of indigenous R and D there should be premium on such utilisation.

6. There should be a statutory Parliamentary Committee on Science and Technology having frequent communication with the scientific and technological community, so as to enable informed discussions in Parliament on scientific and technological issues.

7. There should be a statutory Parliamentary Committee for screening proposals for the import of technology.

K. Ashok Rao
Vice-president
Delhi Science Forum
New Delhi 110 017

ORCHID BREEDER KNOWS BEST

I WAS shocked to read the concluding statement in Flower Guard (Science Shapes Life, May 1980) that efforts to grow orchids from seeds have not been successful.

The orchid seeds, unlike other angiosperm seeds, lack any functional endosperm but it has been possible to successfully grow the orchid seeds on various nutrient media. The growing of orchids through seeds was standardised way back in 1922 when Dr Knudson grew the orchid seeds on nutrient media. At present there are more than 45 000 registered orchid hybrids in the world and all of them have been raised through seed. In the USA, Europe, etc. standard pre-pH adjusted media are available for orchid hobbyists to grow their seeds. We at Bangalore have been growing orchids through seeds and a large number of hybrids have been raised. Hence, the statement quoted above is totally incorrect and misleading.

Foia Singh
Orchid Breeder
Indian Institute of Horticultural Research
Bangalore 560 080

SILENT VALLEY

IT IS not correct to say that the Silent Valley (May 1980) is the last habitat of the tiger and the panther although it may be true of the lion-tailed macaque and the Nilgiri langur. Fig. 6 on p. 45 depicts *Thunbergia mysorensis* the first part of which named in honour of an early botanist who did much for the flora of Japan has been misspelt in your caption. Again, Fig. 5



Pectalis gigantea

shows the flowers of a large-leaved orchid with a haunting fragrance. *Pectalis gigantea*. It is not *Pilea* as your caption says.

T. Ananda Rao
Emeritus Scientist
Botanical Survey of India
Howrah 711 103

A DIESEL TREE?

READING Col. Heber Duthy's book *The Useful Plants of India* (published 1873, reprinted 1978) I came across the following passage:

Dipterocarpus laevis - This tree is in favour over eastern India and the Malay Islands on account of its yielding a thin liquid balsam commonly called wood oil and known as Gurjun balsam. A large notch is cut in the trunk of the tree near the ground, where fire is kept until the wood is charred, soon after which the liquid begins to ooze out. The average is 40 gallons (181.8 litres) in one season. It resembles in a

remarkable degree the balsam of copaiba, and has been used as a substitute for that medicine."

Can any SCIENCE TODAY reader enlighten me as to whether this wood oil has been analysed for its fuel value and whether the copaiba oil referred to above has any connection with the diesel oil tree *Copaifera langsdorfii* mentioned in "Oil Trees of Brazil" (Science Shapes Life, November 1979)?

P.S Mani
Dy. Director of Agriculture
Farmers' Training Centre
Paramakudi (Dist Ramnad)
Tamil Nadu

RELATIVE HUMIDITY AND VENTILATION

IN THE article "How Thermal Stress Affects Workers" (May 1980), Dr Pennathur says that relative humidity and velocity of air are the main factors which affect one's tolerance for a given temperature, and as the relative humidity decreases, the tolerance for that temperature increases He gives a curve (graph) also, which clearly mentions that as humidity rises (that is, wet bulb temperature rises), the effective temperature rises for a given dry bulb temperature

Further, he mentions that in dry heat, when humidity is low, desert coolers increase the humidity and bring down the effective temperature—which seems improbable In a desert cooler, the air gets cooled as it passes through the water-pads, but if the cooler is run in a closed space for a long time, the humidity rises and one starts feeling uncomfortable.

Ranjit Rai Aggarwal
2/3, Desh Bandhu Gupta Road
New Delhi 110 065

Dr. Pennathur writes: *Relative humidity and ventilation (air velocity and displacement) are the main factors that affect one's tolerance for a given temperature. As the humidity decreases from high levels, the tolerance for that temperature increases.*

In dry heat conditions, the relative humidity is very low. In desert coolers, humidity is induced through the circulation of water in the rear and side panels. Because of the high dry heat, the moisture induced into the room by the fan in the cooler evaporates readily This process of evaporation absorbs the latent heat from the air in the room and thus brings the temperature down.

If the cooler is run in an enclosed space for long, the humidity in the room goes above tolerance levels (that is, 70 per cent) and creates discomfort because the room is closed and, thus, there is no air displacement' Air displacement is an important requirement for lowering the effective temperature. When the room is 'open', the air with evaporated water is expelled and fresh, moist air blown into the room by the desert cooler

FOOT-AND-MOUTH DISEASE

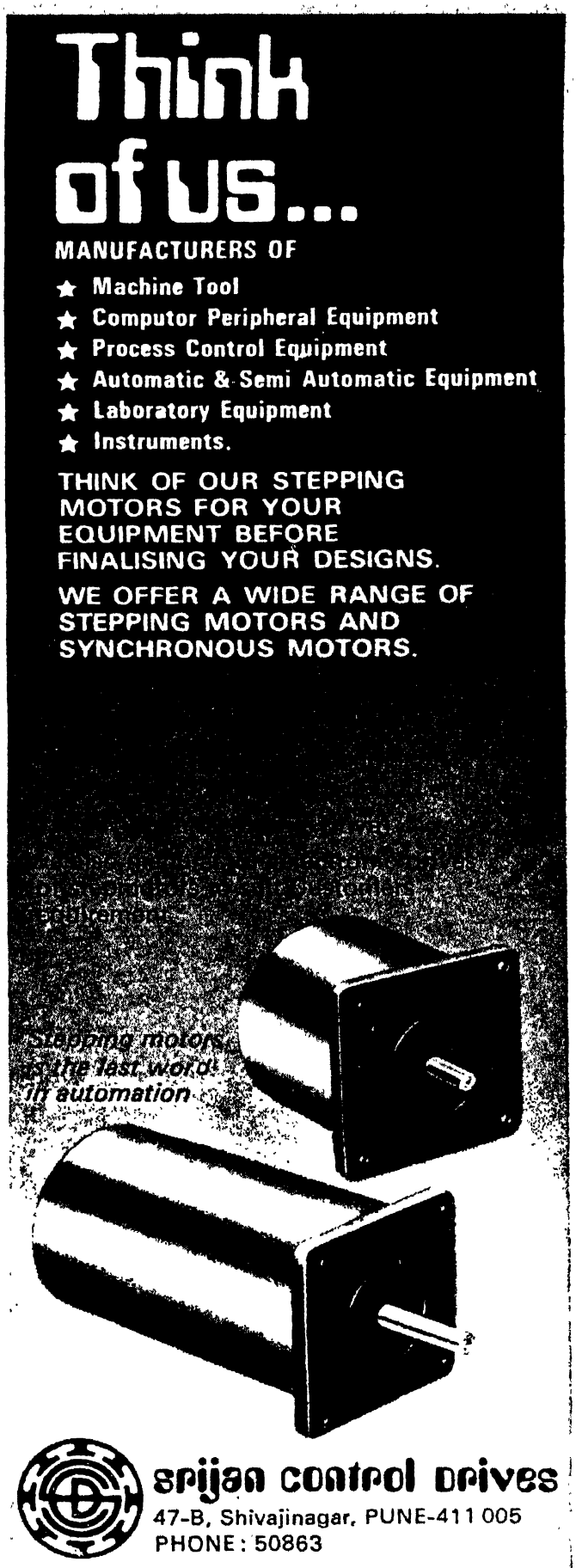
IN "Foot-and-Mouth Disease Vaccine" (Science Shapes Life, April 1980), it has been stated that foot-and-mouth disease (FMD) affects cattle, sheep, swine, horses and some other hooted animals. It is, however, seen that horses are not affected by FMD Single-hoofed animals like horses and donkeys, are resistant to FMD

S K Rahman
IV Year, College of
Veterinary Science
Hyderabad

RADIUM DIAL WATCHES

I SUBBARATNAM ("Radiation Protection in Nuclear Medicine" June 1980), quotes "a marked increase in the incidence of bone cancer in radium dial painters" and I vividly recollect having read some time ago about the Swiss government's ban on the use of radium for dial painting on watches. Why, then, do other countries, including India, which manufacture watches not take the same precautionary steps? Also, what harm can the continuous use of such radium dial watches do?

Ajit M. Mankar
85 Lakshmi Nappoo Rd
Dadar, Bombay 400 014



Is PRL science relevant to India?

THE Physical Research Laboratory (PRL) in Ahmedabad was set up in 1948. Started by the late Prof. Vikram Sarabhai from grants from an educational trust, it later acquired the status of a national laboratory. And now it is solely supported by grants from the Government of India. Of its total budget of Rs.2 crores for 1979-80, Rs.1.7 crores came from the Department of Space of the Central Government, and Rs.0.24 crore from the Department of Science and Technology. The Gujarat government contributed Rs.1.3 lakhs, and another Rs.0.6 lakh was given by private educational foundations. The balance came from the income from the commercial use of the computer at the PRL.

While debating the role of basic and applied sciences in relation to the country's needs, therefore, the PRL can be taken as an example. What has it contributed to the country's development? How far have its research programmes been relevant?

Let us take a cross-section of opinions of scientists working at the PRL.

According to Prof. D. Lal, director of the PRL, there is nothing like priority in science at the PRL "The scientists select their own problems and I try to support them." Prof. S.P. Pandya, deputy director, says: "It is true that we have not given much thought to the relevance of scientific programmes to the need of the nation. Historically, the scientists have pursued the activities of their choice."

The PRL has about 40 scientists of high competence. Most of them interact with foreign scientists and their interaction outside the PRL in India is insignificant. It seems that the activities of most scientists are in overall support of foreign science activities, specially the USA. It is fair to say that the PRL is a laboratory working for the scientific goals of foreign countries.

The decision to start a programme of infrared astronomy, which is partially completed and may cost about Rs.2 crores, is an arbitrary one. The director has taken a decision and we have accepted the challenge to carry on and hope to do the best we can.

It might not have any relevance to the needs of the country and some may even call it a waste of resources.

The programme of hydrology and palaeoclimatology is an important one and has great relevance to the nation. However, the efforts are insignificant and not in the main stream of the PRL activities.

There will not be any negative impact if the present PRL activities are stopped.

Science in the PRL grew around a person and, therefore, activities in general are scattered. It would not be wrong to remark that the culture PRL inspires is to do science for science. The question of relevance is never raised.

There are many outdated research activities which need to be stopped. The PRL should have a defined goal which every one should know. There should be total evaluation of all scientific priorities.

These are the opinions expressed by members of the science faculty. Clearly, the concept of relevance to the needs of the nation is foreign to PRL.

What is relevance, anyway? The following observations may be made against the background of basic space science in which the PRL is presently engaged.

1. One may advance the view that basic research for the sake of basic science is a novel goal and thus the question of relevance to the national need should not arise. Under this umbrella, one can do whatever one wishes.

2. Another view may be put forward that one may be engaged in basic research with a definite goal in mind that the results of such an activity will be useful in support of a national goal. Such results may be needed within the next five to 25 years.

Any basic research which falls in the second category should be considered relevant to the national need. The research in the first category where a time frame is not used is irrelevant. The views expressed here should be taken in the light of these restrictions. The main thrust of the PRL activities is being directed towards deep space research and this falls in the first category. Let us take a look at the main activities of the PRL.

Infrared astronomy: The main objective of this programme is to study the infrared sources in space. It includes the photometry of young open clusters, mapping of dark clouds, studying binary stars of which at least one component is exclusively in the infrared, etc. All these objects are far out in space, the nearest star being approximately 5,000,000 billion km away. The aim of such studies is to know how these stars are formed and what are their physical properties. But the priority of such a study needs to be questioned. Recently, scientists from the PRL and the Tata Institute of Fundamental Research (TIFR) observed an object MXB 1730-333 which is already known for X-ray bursts and found it to emit infrared bursts as well. This may be a good observation but has it anything to do with what India needs today or 50 years from now. The PRL is also in the process of setting up a 48-inch telescope for this type of work at an estimated cost of Rs.2 crores. It is argued that this telescope will be exclusively for this type of work and may generate a large number of data on infrared sources in space. Good indeed. But how do these observations, in the name of scientific freedom, help India? When I discussed this with scientists at the PRL, many questioned the need for this project. The project leaders said that it was just like any other basic science, which falls in the first category of relevance-definition. It should also be noted that the much publicised infrared burst was observed at the Kavalur Observatory of the Indian Institute of Astrophysics, near Bangalore, which has a one-metre telescope. Another identical facility, a one-metre telescope, is at the UP State Observatory at Nainital. Although these telescopes are not meant for the specific use at infrared wavelengths, they have been used to detect infrared radiation. And both these facilities are available for the study of stars. Besides, there is a plan to set up a four-metre telescope at Nainital. This by itself is uncalled for, and, in any case, it eliminates the need for the 48-inch telescope at the PRL Can an exclusive facility for the kind of research which has no bearing to the need of the nation be justified?

Nuclear physics: Research in nuclear physics is divided into four areas—nuclear physics, atomic and molecular physics, climatology and meteorology and plasma physics. The research in nuclear physics is out of phase in the PRL as it is not in the mainstream of space research which is the ultimate goal of the laboratory. This group came into being as a result of the so-called PRL culture, according to which activity grows around a person. While discussing the relevance of this group in the PRL, one scientist remarked: "We are somehow here; no other place to go and, therefore, we shall stay whether liked or not". It might make sense if this group is transferred to the Atomic Energy Commission.

The atomic and molecular physics group consists of one scientist who is currently engaged in calculating the collision cross-sections of low-energy particles with atoms. This type of fundamental research should be done in the universities where scientists do whatever they wish. Climatology and meteorology, by far the most relevant programme at the PRL, is at a low ebb.

It can hardly be called a significant group and its activities remain unnoticed while, in fact, this group should grow. The plasma physics group is involved in studying the basic processes related to the problems of astrophysical and fusion-oriented plasma. The problems of astrophysical plasma are oriented to deep space research whereas fusion plasma is related to controlled fusion. Astrophysical plasma study has nothing to do with national development. The research on fusion plasma is more of a scattered nature. In the absence of a national commitment to fusion energy research, it has also very little relevance. Surprisingly, the study of theoretical fusion plasma is not in any way integrated with experimental plasma. And ironically, the two groups, namely, experimental and theoretical plasma, do not have a common goal.

Solar and planetary physics: This is the largest group at the PRL. Its activities include the study of the sun, the earth's immediate environment, the interplanetary medium, the magnetosphere, the ionosphere and geomagnetism. It may be considered a mixed bag. The activities of this group are not encouraged by the director. Therefore, there is no scope for any new activity, no matter how timely or important the proposed research effort. In accordance with the policy of deep space research, an Interplanetary Scintillation Station (IPS) has been set up at Thaltej, Ahmedabad, and two similar stations will be set up at Rajkot and Surat to form a complete telescope. Such a radio telescope will be used for studying the transits of radio sources in space. This is almost similar to the study of infrared sources. It is hard to justify this programme from the point of view of relevance. If properly oriented, it can be turned into a very useful group. The study of the earth's atmosphere has direct relevance to meteorology, climate, communication, etc and as such, the emphasis can change to meet the objective. However, there is no sign of such a change.

Laboratory plasma and astrophysics: This consists of two groups—experimental plasma physics and laboratory astrophysics. The main experiment in plasma physics is the relativistic electron beam and plasma interaction experiment which is now operational. The objective of this experiment is to carry on a diagnostic study of the basic processes in plasma and measure some fundamental parameters, like ion temperature, ion-density, microwave and X-ray emissions resulting from hot plasma. This programme is said to be the beginning of the fusion energy programme. Though it may seem to be a novel goal to some, to me it looks like a point of super-salesmanship. If the programme is intended for basic science, which, in my view it is, then the relevance is limited.

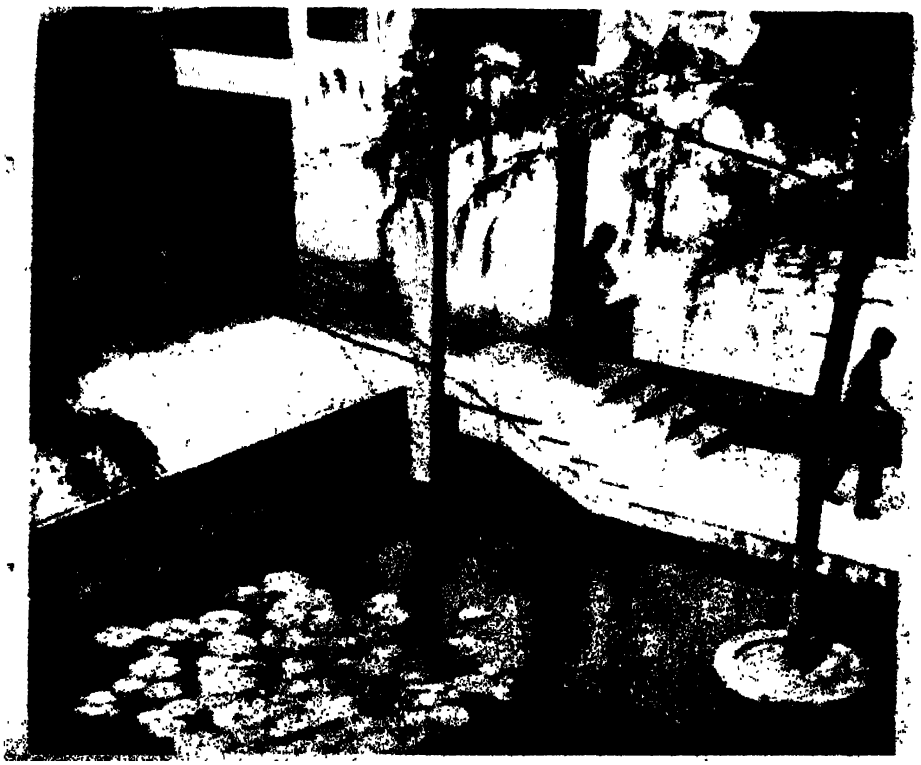
Wisely, India has not committed so far to fusion energy research. The resources required for such research and development effort would be very high. The state of the art for fusion energy research is changing very fast and the type of technology required would be clear only by the year 2000, if at all fusion energy is controlled. India has to put up more resources per capita than the United States if a decision is taken for fusion research. In my view, if fusion energy is controlled, the technology should be imported and personnel trained on the same pattern as in the case of atomic energy. Therefore, to talk about the relevance of relativistic electron beam and plasma interaction experiment in relation to fusion energy research does not mean much.

Under various titles like photoelectron spectroscopy, ionic fluorescence, vacuum ultraviolet scintillators, the study of the interaction of photons with atoms and molecules of astrophysical interest is being carried out in laboratory astrophysics. In essence, such a study will throw light on the basic properties of molecules and yield the values of some parameters which will define the magnitude of those properties. This laboratory was created four years ago with an annual budget of about Rs.4 lakhs. The research in this laboratory is not in support of any field experiment at the PRL, but simply consists of basic research in spectroscopy. This type of work should be done in the university rather than in a national laboratory.

Compare this with the spectroscopy laboratory of MS University, Baroda. It has a 30-year-old spectrograph and locally made radio-frequency oscillator. With these two primary units, basic molecular properties are measured. The aim is similar but unsophisticated as compared to the PRL. It has an annual budget of less than Rs.10,000. The laboratory is producing PhD students and a good number of publications.

Archaeology-hydrology: Among the activities of this group, the areas of palaeoclimatology and hydrology are important to varying degrees. The study of palaeoclimate aimed at predicting the future climate may be considered important and should receive more support on a long-term basis. The hydrology programme as applied to the Sabarmati basin in order to study the recharge and discharge of underground water and other related aspects should be considered not only important but of great significance. Unfortunately, such work is not in the main stream of the PRL activities and does not get much support. Most of the financial support comes from outside agencies and it barely keeps the group alive. The impact of such programmes will not be felt unless their

A sectional view of PRL



scope is widened to cover important regions of the country. Considering the direction in which the PRL is heading, this group may not expand Actually, a separate institute should be established for such work with sufficient resources of men and money

Geocosmophysics: The primary objectives of lunar, meteorite and cosmic ray research in geocosmophysics are (i) to understand the nature of the energetic particles emanating from the sun and other galactic sources and their interaction with extraterrestrial materials, and (ii) to decipher the dynamical processes leading to the formation and the evolution of meteorites, asteroids, etc Geochronological research seeks to study the evolution in time and space of the various rock formations The investigation is based on the Rb-87—Sr-87 technique in which Rb and Sr isotopic abundances in rocks and other samples are measured Research in the aqueous geochemistry area is aimed at understanding the details of transport, distribution and deposition of selected elements in the marine environment The studies include the deposition and accretion rates of marine sediments and manganese nodules, geochemical behaviour of selected elements in the estuarine zone, the dynamics of deep-ocean circulation and particulate transport of materials in the ocean water column, etc The laboratory of geocosmophysics is the best equipped in the PRL most probably in the world It has all the latest and sophisticated instruments This could be possible only because of the generous support of the director whose professional interests are identified with this group

Is this generous support justified? If given to a laboratory with a great potential to the need of the nation, such support is welcome However, the laboratory of geocosmophysics does not qualify by this criteria All the activities of this laboratory has the primary aim of studying matter in time and space which does not fit within the criteria of relevance laid down earlier However, if the primary aim of aqueous geochemistry is widened and changed and then integrated with the hydrology group, it might qualify for limited relevance The other two areas of meteorite and geochronological research do not have much that can help the development of the nation

PhD programme

Another important activity at the PRL is its PhD programme It is intended to provide scientific manpower to the country The best talents are recruited for this programme, and highly specialised PhD graduates are produced But they are so specialised that their training cannot be utilised outside the PRL anywhere in India And they cannot be absorbed in the PRL Among the 28 PhD graduates produced since 1971, only eight are in the PRL, ten have gone abroad where they could fit very well and the other ten are employed in universities and colleges where their training has hardly anything to do with their work In fact, after graduating from the PRL they become unfit for university jobs The net result is that these graduates are more suited to the advanced western countries like the USA and Canada It is not the aim of this programme to train and supply scientific manpower to other countries, but in a sense it has become

There are 40 scientists in the PRL now Most of these are quite competent Their research activities are more akin to the interests of foreign scientists, specially those in the US and are in a way alien to the needs of India Their research interests are motivated partly by the training they received abroad and partly by their desire to keep contacts with scientists abroad The latter enables them to make foreign trips, which are very beneficial, financially and otherwise, though, in the process, national interests become secondary It is true that the salaries of these scientists are not adequate to support their family in a decent way compared to the living they enjoyed abroad Besides the scientists are highly individualistic, to some extent ego-centric, and unwilling to change their line of work Younger scientists are more receptive to change than the senior scientists

Some scientists argue that basic research can be justified I agree But opinions differ when the priorities in basic sciences are to be set If there is a basic science with a time concept of five to 25 years (an arbitrary limit depending on the need) to meet a definite goal, it may be justified even if a national laboratory is to be set up for the job But we have over 100 institutions like universities, IITs etc which do basic research without any definite goals The largest scientific manpower is thus devoted to basic research Should a national laboratory get involved in basic sciences? If yes, then how many laboratories should be allowed to go that way? The answer to these questions cannot be satisfactory to all But the debate must begin from the bottom to the top and a consensus arrived at while keeping in mind the concept of relevance

It would be appropriate to make a few remarks about science policy in India in general and the PRL and the TIFR in particular The TIFR has been provided with all the facilities, and in relation to Indian conditions, research in the TIFR is a luxury. In the last 30 years, it has mainly devoted itself to basic sciences, specially to cosmic rays What has it given to the nation in terms of science which has touched our lives? The answer to this question is negative And the answer applies to the PRL as well

During my discussions, I was told that the TIFR and the PRL have provided people who are running science in India If it is so, it is not good, these scientists, thinking alike, will take the country in the same direction, and support and defend each other Probably it is so and, therefore, the total absence of a lively debate on scientific priorities It is the working scientists who must get involved in the decision-making process

In the beginning of the article, the term 'relevant research was broadly defined By this definition, results arising from fundamental research must be useful in support of a national mission within a reasonable period of time, say 25 years To be more specific, our country cannot afford to invest men and money in science without expecting fruitful results for the benefit of the people In the last 33 years of PRL's existence, there is hardly any research done which one may classify to be of importance to meet any specific need of the country One may ask, What kind of research should the PRL undertake to make itself relevant' In my view, the PRL should serve as a prime centre for research in atmospheric physics of the earth It should concentrate on the problems of research related to the input of solar radiation, the reservoirs of energy—the land and ocean and their interaction with the atmosphere These efforts should be directed towards the better understanding of the behaviour of the atmosphere in relation to communication, environment and climate As we are heading towards industrialisation, the study of the impact of atmospheric pollution on the environment and climate should form an essential element of the PRL activities as well

SHARDANAND

Dr Shardanand is a Visiting Fellow at the Physical Research Laboratory Ahmedabad He obtained his PhD in atmospheric physics in 1961 from the University of Allahabad and taught in the Department of Physics as an assistant professor From 1963 to 1978 he worked for the National Aeronautics and Space Administration of the USA

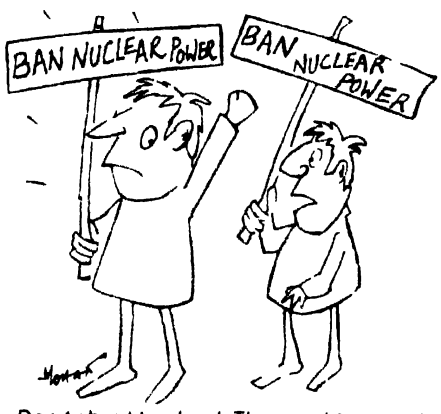
He acknowledges the help provided by many members of the faculty and students at the PRL with whom he had detailed discussions which shaped the subject of this article

Government, science and technology—
Twilight of the gods

THE great achievement of the Soviet Union in putting Sputnik I into orbit was a great stimulus to the American people It spurred us into action So great was the inspiration that perhaps we overdid it Not only did we put satellites into orbit but we went so far as to put men on the Moon It was on the whole a very great technical and political event At the time the General Conference of the International Atomic Energy Agency met in Mexico City, in 1972, I made a little speech in which I turned to the Soviet delegation and asked, 'Isn't it time you did something for us again? We need you very badly' You may doubt the wisdom of putting men on the Moon, but it was an achievement which required great faith and a great forward-looking spirit, which we then had Some people may say that it wasn't worth the cost When people said that to me I replied, 'Well, you saw it on television Was it worth five dollars to you?' Yes ' Well, that is all it cost—five dollars from every person

Now the world seems to have changed Everywhere we hear stories about loss of faith —a loss of faith in human powers—and about the rise of a kind of radical conservatism We have become afraid of ourselves, afraid of our achievements There is now great concern only about safety The daring of the concept of putting men on the Moon is almost inconceivable now We worried at that time lest we might catch some disease as yet unknown—a Moon disease At that time I thought it was rather silly, perhaps an expression of conservatism, but not entirely baseless Now the public would look at this in a very different way, we would have to prove 100 per cent safety even before landing Although I'm talking about the United States, I don't think it is the US public alone which looks at things now in this way In countries which in the past have been great leaders in discovery and the advancement of science and technology, this faith—the foundation of the modern world—is beginning to weaken It is a loss of inspiration and of faith in the powers of the human spirit—a loss of the sheer joy in taking part in the achievements of which humanity is capable More and more, other concerns have taken over Concern about the quality of the air, the quality of the earth and rivers, and enormous concern about other forms of life, and much less concern about human life itself To people with such extreme views, extreme self-hatred, the existence of humanity seems a kind of blot on the face of the earth

I do not propose—I think it is beyond me—to trace the currents which have carried us into this mood I just gave the example of how the great optimism which existed twenty years ago, the kind of optimism which not only sent men to the Moon but has also made possible the enormous machines we use to study the interior of the atom, is now giving way to sentimental concerns about what we do to the environment, about the possibility of harm to one form of life or another, when we penetrate into the unknown Such worries are nothing new From the earliest times people have been afraid of magic and of course science and technology are a form of magic to some of those who do not participate in the struggle to discover the more profound secrets of



Don t shout too loud They might give in to our demands and bang there ends the fun

nature, they do not look at the achievements—either the material achievements in terms, say, of health or the achievement in terms of the extension of human powers We can now see, literally, billions and billions of light years away We penetrate into the atom—the atomic nucleus—and below the surface of what we are into our constituents We have begun to understand some of the most puzzling features of life, like DNA and inheritance through generations

One loses sight of this in the general sentimental desire to preserve a primitive world, a kind of democracy of living and non-living things, in a desire to stop change and in the distrust of progress This is perhaps understandable when you have an old culture and old men in power, but the disturbing thing now is that we see it manifesting itself among young people, in the universities, young middle-class people who have had all the opportunities of learning to understand, respect and glory in the great achievements which we have now before us Unfortunately, it is not only true of the United States but apparently, to a greater or lesser degree, worldwide We have seen such currents before I would remind you how a little over ten years ago a revolt started in Berkeley California, against the "Establishment in the universities. It was not an intellectual revolt, no plan was put forward for better organisation of the university or society It was a revolt, so to speak, against the existing establishment. Young people were unhappy with things as they existed Many did not feel it necessary to criticise, they felt it more important to destroy, hoping that something better would emerge instead It was not a philosophy, but rather a rage

To some extent that feeling has subsided, but not entirely There still exists a feeling that I would call "anti-intellectual against the use of reason as opposed to sentiment in the ordering of human affairs This distrust of the intellect goes together with great concern that nothing detrimental should happen to the environment. This is quite understandable, one has to admit that mistakes have been made in the past In antiquity, the cutting-down of the forests in Italy, for example, led to a deterioration of Roman culture However, we have learned through science how to transcend such mistakes, but will public feeling allow us the freedom to do so? For example, in the United States a proposal for a nuclear power reactor has to run through a whole series of hearings in the courts of law There are organisations of people who fear and oppose passionately and idealistically the existence of such plants. They go further—they demonstrate publicly, marching in the streets to show their political power Brilliant young lawyers of high idealism make use of the courts in such a way that the delay in obtaining any kind of permit becomes so great that, with costs mounting rapidly, no matter what the scientific fundamentals may be the economics become insupportable This conscious effort to delay the appearance of nuclear energy has unhappily achieved great success Of course there is a certain danger connected with nuclear technology, and we share the fear of that danger. However, there has never been a technology—or even a technique or craft—which did not involve danger, if one reads the history of the cathedr-

als of Europe, one finds that for a long time—until the architecture was perfected—they kept falling down, while nowadays many lives are still lost in railroad accidents and aeroplane accidents I am not arguing against the taking of every precaution, but one must realise that there is another side to almost all the kinds of technical advance that have been achieved through the years Whether or not one accepts technical advances depends entirely on the quality of the civilisation on how bold and how daring one is

Friends in European countries tell me that what I am describing is true also of Europe while we see similar manifestations in Japan This tendency will grow and become more and more important Together with it goes something else—a certain loss of respect for the authority of government and of people who know of experts Demands are made for proof upon proof, very often not for the purpose of understanding but for the purpose of delay I m not suggesting that there is a conspiracy however, what I am suggesting is a disease of the times, particularly in the more advanced countries I wondered as a student, and I still do, what happened to the great empires of the past, so solidly rooted, so well organised and with such high civilisations What made them decay? I am beginning to see, in our own age, decay of the same kind setting in for reasons which may be very basic and which our psychologists have not yet understood—a certain loss of faith in the particular culture, in the particular times

These things happen and sometimes with very little warning In the years 1927 and 1929 I was a post doctoral student in Germany where most of the professors I knew paid no attention to the Nazis they were only a small group and seemed trivial Yet the Nazi movement grew explosively and a few years later the whole of Germany was transformed and that great scientific culture was destroyed It was revived after the war but only with difficulty and very slowly Similarly, what has happened recently in Persia shows how dangerous human life is and how fragile our institutions may be even at times when they look very strong

I m afraid I paint a sorry picture, but it seems to me that there are new elements affecting our whole civilisation One doesn't have to go very far back —perhaps twenty years—to a heroic period when the pursuit of excellence in science and technology was very natural for a bright young person who had the capacity for a subject which was very difficult, but very satisfying, with tremendous intellectual charm At the same time the study of physics engineering medicine and so on was not only fascinating but also had the support of the public This is important for people who innovate and discover are not particularly well paid It is more the satisfaction of participating in the advance of science and the general approval of their peers and of society at large which count—the feeling that what they are doing is somehow a good thing, not only good for the strength and the material well-being of the civilisation in which they live but also good in having a higher purpose and in demonstrating the qualities of the human spirit

When one tries to transplant science and technology from a country where they flourish to a country where they have not yet existed, one encounters great difficulties and is rarely successful The problem lies deep in the culture In order to have a scientific culture one must have enough individual citizens who are interested in science and find it a challenge However, civilisations with a scientific culture are something very new The ancient civilisations of Egypt, China, the Middle East and southern Europe were great in craftsmanship and in the arts, they solved many practical problems, but what we call "science" was not achieved until the Renaissance in Europe, about 400 years ago, in quite a different spirit The emergence of the scientific spirit, which seems such an obvious development now, was a strange occurrence if one considers the course of history, and it is this

... and some questions and answers

QUESTION Do you think public sentiment against nuclear energy extends to science and technology in general?

I.I. Rabi: Yes, I do, but I am unable to explain this sentiment either as it applies to nuclear energy or as it applies to science and technology in general President Roosevelt once said "The only thing we have to fear is fear itself." The fear of nuclear energy appears to transcend reason, for people march in protest against nuclear reactors for peaceful uses, but there is very little opposition to the nuclear plants which produce material for atomic bombs

As regards science and technology in general, the dean of one of our great universities recently told me that many students are not so much indifferent as hostile to them "I have not been able to get such people to articulate their attitude in a comprehensible way, so I regard it more or less as a kind of disease which is spreading along with things such as the drug culture and astrology Science was supposed to help one understand the world and how it works, but science is difficult, and as technology has advanced, people's lives have become increasingly easy so that maybe the effort to understand something serious is too great for most of them The rewards which they seek come much more easily from, say, drugs

Q Fifty years ago one had to work in order to survive Now the situation—in some parts of the world at least—is such that there is no incentive to work any more Is this perhaps one reason for the disease which you have mentioned?

IIR I think you are probably right The leaders of what I would call the "anti-intellectual" movement against science and technology are from the middle class and possess most of the material goods which society has to offer, so that they do not have the compulsion to penetrate below the surface. They become disgusted sometimes at what is presented on the television but they do not know about or do not understand the great beauty that is behind the screen in the design of the set I am afraid that the effort to make young people happier has in many cases made them superficial; I have often been asked why we teach arithmetic to children when they can use pocket calculators for most of their purposes However, the disease came on rather suddenly and maybe, like a cold, it will go away by itself—but I doubt it

Q. Is the disease perhaps due partly to the fact that scientists have not done enough to inform the general public about the development of science and its importance?

IIR It probably is When science was accepted—or at least not attacked intellectually—there was no pressure on scientists to explain to the public what they were really doing It was different in Europe during the last century, when science was under continual attack from the side of religion and philosophy At that time, many scientists, such as T H Huxley, wrote brilliantly Recently, however, the pressure has diminished and scientists have on the whole lost the habit of writing well, although some very good books are still being written about parts of science—popular books like "The First Three Minutes" by Steven Weinberg

Moreover, it is very important to remember that the scientific community is not homogeneous There are scientists

[illegible] the public with the majority of scientists on one side and a small group of them on the other, it says "The scientists don't agree" and is confused. By "the public" I mean not just ordinary people but also journalists, who also lack an appreciation of science. Strangely enough, with the march of science, that section of the public which does appreciate it is becoming a smaller and smaller elite; the rest of the educated population does not participate in science and some even hate it. Perhaps this is because science is expressed in a language which has to be learned when one is young and we are not teaching that language properly to enough young people.

Q: Do you think that governments are the right institutions to set national and international goals and priorities for science? Maybe putting a man on the Moon was not the right goal; maybe the resources could have been employed more usefully in developing, say, better agricultural technologies or safe and more energy-saving transport systems.

IIR: That is not how humanity is organised. I was not in favour of putting a man on the Moon, but there is no guarantee that if we had stopped that project the money would have been spent in the areas you favour; it would probably have gone into armaments. Also, for a while we did derive a tremendous amount of inspiration from the Moon programme.

I don't know who, apart from governments, could mobilise the large resources that are required. Perhaps the multinational companies could, but I don't think they would be allowed to. So I think one is limited to governments—or to combinations of governments as with CERN in Geneva, where 12 governments are together supporting very high-energy research. The sums of money involved are very large, but we [illegible] are spending it on efforts to obtain a better understanding of the structure of matter. We should not be wondering whether the money could be spent on something else. When the cathedral of Notre Dame was being built in Paris, some people probably thought that the money should be spent on healing disease and helping the poor. Well, I'm glad they built the cathedral.

Q: If governments were headed by scientists and technologists, would that help to solve the problems that you have mentioned?

IIR: In large projects where scientists and technologists play an important role, things work well, as in the case of CERN, and I see no reason why a command of science and technology should prevent a person from being a good politician. It is true that the achievement of deep understanding and thorough competence in scientific fields doesn't always go with the expansive nature of a man who seeks political power. If we had a proper educational system, however, I think we could produce enough people with abilities in both directions.

Q: Don't you think that it is necessary to humanise science and technology so that the faith of people in them can be restored? And what can the academic community do about it?

IIR: I should like to take issue with the word "humanise"; science and technology are made by humans who have fathers, mothers, brothers, sisters, wives and so on. Often, when people say "humanise" they really mean "dehumanise". Things like mathematics and physics are subject to the rational intellectual process—they are human. On the other hand, many of our sentiments are shared by all mammals.

As regards the academic community, universities are a product of the culture. If the culture demands higher standards, [illegible] universities will produce higher standards; if it demands lower standards, as it has recently, the universities will produce lower standards. So, we are really talking about the nature of the culture in which we live. For example, we do not yet know how to handle the power of television, which can affect the mood of the public but is often in the hands of a very few people who are exploiting it for limited purposes. I am not sure how compatible this situation is with the survival of democratic institutions; younger people will have to analyse and do something about it.

I have the feeling nowadays that we are in a very powerful vehicle that sometimes jumps the track. After all, we have seen this century how a culture can jump the track.

Q: In recent years, many scientific achievements—such as the discovery of nuclear energy—have been used initially for destructive purposes. What, in your opinion, is the reason for that?

IIR: Using the highest achievements of science for human destruction is an abomination, but I think we are organised globally in such a way that there is very little freedom for our leaders to act differently.

It is something to do with our priorities. We prefer to fight, even with nuclear weapons, rather than face the destruction of our culture. At the time of World War I, which was fairly similar to our present times, most people in power considered that it was their culture which was at stake, but their culture didn't survive in any case. I think our education system must instil a kind of wisdom that will counteract the fears which each side induces in the other. After all, if you were a ghost looking at humanity after a world war, you would wonder whether all the destruction had been worthwhile, and I think you would come to the same conclusion as me.

spirit which we have to preserve. However, if we begin to lose faith, so that young people who have the capacity for science are not supported by their peers and do not feel that they are doing something good, the scientific culture may dry up and die.

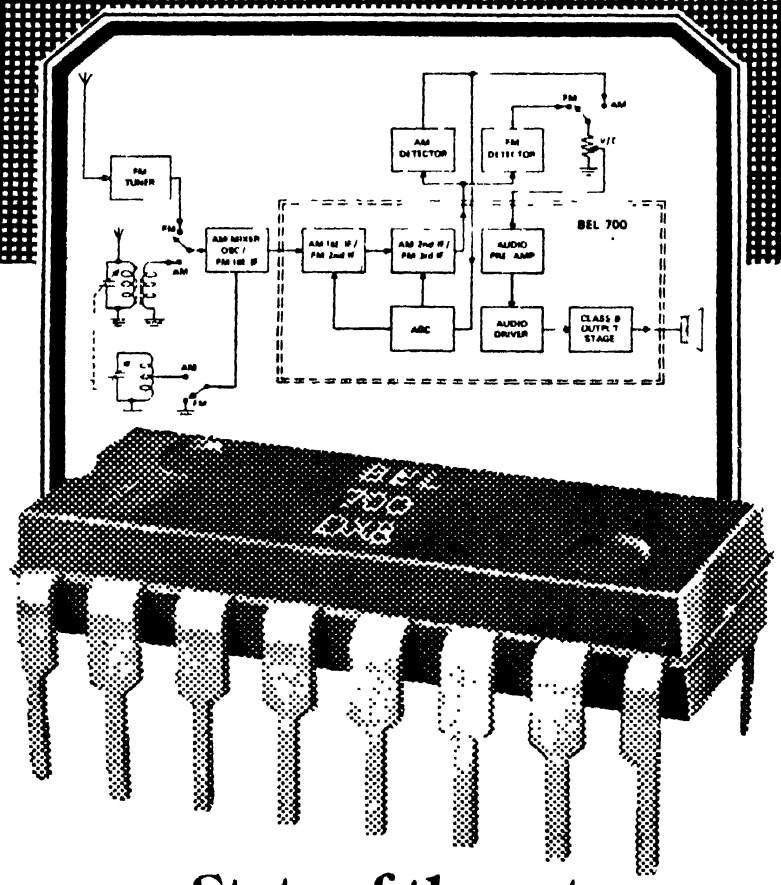
I feel we are up against a global disease. At the time of the great student disturbances in the United States, people said that the students were protesting against the war in Viet Nam—and so they were, but at the same time similar disturbances were occurring in countries which had nothing to do with Viet Nam. I think it was a kind of revolt against intellectual things and against "the hard sciences". There are many people in many countries who are ready to step in and take advantage of such a revolt and who would like to control science not by learning it but by talking about the ethical responsibility of the scientist. You find ministers who have no idea what science is about, but who are great experts in ethics and will tell you what you can and cannot do in, let us say, biological research. At the same time we see a great increase in the number of people studying "the soft sciences" and also a great increase in superstition of various kinds. I don't like creating such a pessimistic impression, because even as a scientist one does not want to suggest that the subject with which one is concerned can be the object of doubt by reasonable men. However, I think we have a problem about which something must be done.

I would like to see a revival of the spirit of initiative and daring so that we can again attack our problems rationally, knowing the risks but taking them. I would like people all over the world to realise that we are a global community and that an injury to one part of that community—whether physical, psychological or cultural—is an injury to the whole. So what I am calling for is a conference which will revive the flagging morale of science and technology, so that we can once again rely on the ability of the human spirit courageously and boldly to find rational ways of solving our problems.

ISIDOR ISAAC RABI

Dr Rabi, the 1944 Nobel Prize winner for physics, is Emeritus Professor of physics at Columbia University New York. This is an abridged version of an article published in the IAEA *Bulletin*, Vol 21 No 5

With BEL 700 tomorrow's AM/FM radios will have fewer components, but work more efficiently.



State-of-the-art design know-how for radio receivers with BEL 700

One BEL 700 IC replaces six discrete transistors, one stabiliser diode and associated resistors—improves performance and simplifies manufacture of a radio.

Features

- Class B output stage (1W)
- Output stabilisation circuit
- Audio Driver
- Audio Pre-amplifier
- Two stage IF amplifier
- AGC
- Stabilised bias circuit
- Supply range : 2.7 to 12 V
- 16-lead dual-in-line plastic package
- High sensitivity even at low voltage

Application

AM, AM/FM receivers and audio amplifiers

BEL—leaders in professional electronics

BHARAT ELECTRONICS LTD.
(A Government of India Enterprise)
Bangalore • Ghaziabad • Pune

For further details contact :
The Deputy General Manager (Component-Sales)
Bharat Electronics Limited
Jalahalli, Bangalore 560 013

Or our Sales Depots at :
- 2/12, Ansari Road, New Delhi-110 002. Phones : 264448 & 273092.
- 4th Floor, Sukh-Sagar, S. Patkar Road, Bombay-400 007. Phone : 359347.
- 5th Floor, Chatterji International Centre, 33A, Jawaharlal Nehru Road, Calcutta-700 071 Phone : 249261.

CAS-BEL-7943

Science Shapes Life

REFINING REFINERIES FOR THE FUTURE

As the world's petroleum production levels hit the bottom, refining practices will have to change The crude will become heavier, more viscous and will contain a lot more contaminants Can the present-day refineries cope?

James R Murphy, manager of process technology in Pullman Kellog, an American firm, foresees the need to redesign refineries to meet the changing needs of the future Before the oil crisis, refineries were expected to grow and serve a variety of customers with various byproducts The petroleum industry spawned several other industries in its wake The new designs are expected to cater to new objectives There will be no byproducts with a market value less than that of the parent crude and most of the output will be fuels for transportation

How will the new refineries differ from the present-day ones? The basic changes, of course will be to process heavier crudes to lighter fuel fractions Murphy suggests that a common feature of the new refineries will be uniformity as a result all will have the same product slate Hydrogenation and desulphurisation will be considerable as the crude levels sink Probably catalytic reduction will become the most popular process Researchers are now looking for ways to reduce the cost of the pretreatment prior to catalytic reduction Pretreatment is essential to overcome poisoning by sulphur and heavy metals such as vanadium Residual asphaltenes and pitch according to Murphy, will be used instead of naptha or light hydrocarbons for hydrogenation And the whole refinery will be fuelled by coal!

CANCER CELLS PUT TO WORK

Cancer cells cease to age they become immortal Two Stanford University (USA) scientists have made use of this characteristic to evolve a continuous source of antibodies -- the body's guard-cells By coaxing antibody producing cells to fuse with cancerous cells, we can theoretically get immortal antibody-producing cells

Lennart Olsson and Henry S Kaplan, the Stanford scientists, successfully fused healthy spleen cells with cancerous bone-marrow cells and found that the resulting hybrid also produced the antibody which the original spleen cells had done The fused cells are called hybridomas Mouse hybridomas producing mouse antibodies have been around for quite some time Olsson and Kaplan's human antibody producing hybridoma is the first of its kind The spleen cells they used were exposed to a foreign substance — sheep cells — prior to their fusion with the cancerous partner The resultant fused cells produced antibodies to the sheep cells

The technique opens up several new vistas for the detection of certain diseases like cancer, bacterial and viral infections and damage due to heart disease The large supply of pure antibodies will be useful in studying human disease and will be used as a back-up for the body's immune system They could also be used to aim drugs at the target tissues The Stanford researchers are now trying to pair the easily obtainable beta-lymphocytes (antibody-producing white blood cells) with cancer cells

SET A MOULD TO TAME A MOULD

Apergillus flavus, the notorious mould, produces the deadly toxin called aflatoxin This toxin is a potent carcinogen and contaminates several foodstuffs The mould can grow and sporulate in stored seed, hitch hike with insects to fields—and infest the next stand of crops. Can we get rid of the toxin? Probably we can stop it from producing the toxin

Donald T Wicklow, microbiologist, SEA Northern Regional Research Center, Peoria, USA, has found that when the mould faces competition, it ceases to produce the toxin "No toxins were detected', he says, "when *A flavus* was paired against either *Apergillus niger* or *Trichoderma viride*" In laboratory experiments *A flavus* could not compete with *T viride* With *A niger*, it grew well but produced no toxin Similar results were found with many other moulds too if the latter were given a five day growing start in the experiments using corn as substrate In

AIR POLLUTANTS STUNT PLANTS

Plants are adversely affected by pollution and even if the external damage symptoms are not visible subtle effects on metabolism are reflected in reduced yields A team of researchers from the Institute of Science Bombay, who studied the effects of industrial air pollutants on plants found that the yield reductions, measurable as dry weight shoot length and chlorophyll contents, were consistent and proportional to the intensity of pollution

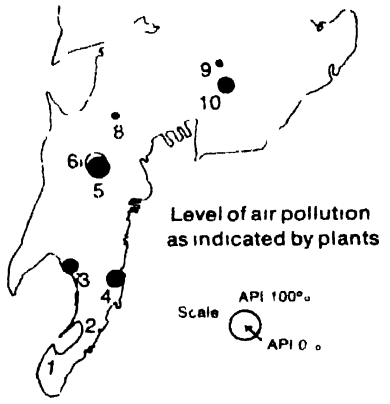
S B Chaphekar, D B Boralkar and R P Shetye used the pollutant sulphur dioxide as an index for their study, since it is the most common phytotoxic industrial emission in Bombay

They grew identical sets of plants in the laboratory and distributed them in 10 different localities in the city Volunteers were responsible for comparable watering of the pots kept in identical situations on terraces of houses

After four weeks exposure to the ambient air, the pots were brought back to the laboratory and analysed for simple parameters like shoot length and shoot dry weight

The plants from the known cleanest spot were treated as the control and reductions in the observed values at other places were calculated as percentages Addition of the percentage losses in shoot heights and weights were used to arrive at Air Pollution Indices (API) Using the API value as a radius and the dot indicating the area of exposure as the centre, circles drawn were placed on the map of the city, bigger circles indicated proportionately higher pollution levels

In another experiment, dust loads on leaves of common trees in the cities were determined throughout the eight dry



months of 1977-78 Leaves collected from 20 fixed spots at regular intervals, and their dust loads, were determined The areas of leaves were measured and dust fall was expressed as grams per square metre The dust load was very high along roads with heavy vehicular traffic and in industrial areas

Industrial air pollution stunts plants The plants at the left were grown in a relatively clean area whereas those on the right were grown at a polluted spot



these cases it was apparently which mould got the foot-hold first that mattered. Only with yeast, did the mould compete successfully at all times.

The scientists suggest that failure to detect the poison could mean that either the mould was inhibited from producing it or that *A. niger* somehow destroyed the toxin. The next question is naturally: "Could not this property be bred into corn?"

T. viride has another use, too. It can prevent fungus disease in Perry pear trees. It is also a mortal enemy of another fungus that destroys many useful fruit trees. Scientists at Long Ashton Research Station near Bristol, UK, have found that *Trichoderma* renders the deadly fungus, *Chondrostercum purpureum*, harmless if it gets on to the fruit trees 48 hours before the killer fungus. The Long Ashton scientists have begun using *T. viride* for biological crop protection. Impregnated into wooden dowels, it is driven into holes drilled in trees and then sealed.

THE TRIPLETS ARE QUINTUPLETS, AFTER ALL

The triplet quasar PG1115 + 08 (SCIENCE TODAY, August 1980, p.31) is actually a quintuple quasar. This finding was reported recently by Keith Hege of the University of Arizona, USA, at the meeting of the Astronomical Society of the Pacific in Tucson, Arizona.

Using the Multiple Mirror Telescope on Mt. Hopkins, Arizona, Hege analysed the quasar's image by a technique called speckle interferometry. This led to the revelation that one of the images — labelled A — of the quasar actually consists of three images superimposed one upon another.

Just now the astronomers are taking this bit of news with a pinch of salt. However, there is bound to be further investigation of quasars, one of the most exotic objects in the universe, with the speckle interferometry technique which promises to revolutionise observations of objects as faint as magnitude 15.

DEATH OF A RARE BIRD

On May 15 this year, bird lovers celebrated the hatching of a California condor. The huge bird which is related to the vulture is on the brink of extinction and the US Fish and Wildlife Service and the National Audobon Society are doing their best to study the remaining 20 or 30 birds in an effort to save them. Of the two chicks hatched this year, one died in the hands of a researcher, one died on June 28. The six-kilogram bird, it is speculated, might have died of shock. Whatever be the cause of death the loss is a grave one considering that there were only two nesting pairs this year— only two chicks were born.

The newborn chicks had been constantly under telescopic watch from



The condor chick in the hands of a researcher It probably died of shock

about 400 metres away. But not all information could be gleaned from a distance, and so handling became necessary. It was when the chick was being measured that the it died in the hands of a researcher. As a result, the Fish and Game Commission has withdrawn its permission for the radio telemetry study programme of condors which involves trapping birds and attaching radio transmitting collars

John Borneman of the California Condor Research Center has put forth a few possible causes for the death, like calcium-phosphorus deficiency and pesticide poisoning. Pesticides accumulate in the body fat. Borneman explained that stress can pump out the pesticide stored in the bird's body-fat into the blood stream when stressed and thus cause death. A similar incident had occurred with a brown pelican earlier. Ornithologists are awaiting the autopsy results of the bird's death

THE BEGINNINGS OF THE SOLAR POLES

Every 11 years the Sun's polarity reverses; that is, the north pole becomes the south pole, and vice versa. How does it happen? John M. Wilcox of Stanford University, USA, has found a clue. Wilcox and his colleagues have discovered a magnetic feature in the middle latitudes in both hemispheres about 30° north and south. This feature appears about a year after solar minimum and enlarges and spreads towards the north pole from its origins in both hemispheres. (Sunspots, on the other hand, go towards the equator.) The polarity of these new magnetic features, Wilcox says, will be the new polarity when the field flips over.

This feature is not a new one; going back into previous records, the Stanford scientists found that features of similar characteristics had been found in the same location in five previous cycles (since 1926). When the feature appears it brings about certain variations in the structure of the interplanetary magnetic field. This is because the field depends on the winds blowing from the solar surface.

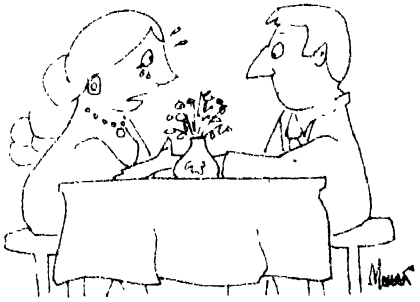
Not very much more is known about this feature, but the Stanford scientists feel that it is probably in some way related to the solar currents (and sunspots) that migrate towards the equator.

CRY OUT YOUR GRIEF

Probably it does really lighten your sinking spirits. Most people feel better after a cry but not after they have shed tears while cutting an onion. Is there any difference between the tears shed in emotion and those shed in response to irritants? Psychiatrist William Frey, the director of Psychiatric Research Laboratory, St. Paul-Remsey Medical Center, Minnesota, USA, is sure there must be basic differences in the chemical composition of the two types of tears.

To test his hypothesis, Frey collected emotional tears from volunteers who were made to cry by exposing them to a touching movie. He then collected irritant-induced tears from the same people and analysed the two samples What he found was indeed surprising: the protein contents of the two types were different. Could that mean that when we are sad we cry away the harmful, stress-inducing chemicals and feel nice as a result? Frey is looking for catecholamines and other such chemicals in emotional tears

Emotional tears, it is thought, are purposeless or at best keep the respiratory tract moist during sobbing But Frey believes that "evolution does not tend to favour purposeless functions." Tears are produced by the exocrine system that is concerned with waste disposal If Frey does find that emotional tears cleanse the system the stiff upper lip had better be allowed to quiver.



"You don't make me emotional, dear, only irritated..."

TEENAGER'S SOLUTION TO ENERGY CRISIS

Elisabeth Breyenton, an American high school student, worked out an interesting problem for her high school science project in Fairview Park, Ohio. Her entry not only went on to capture the grand award at the 1979 Inter-

national Science and Engineering Fair held in San Antonio but also caught the eye of the US Army, Air Force, US Department of Agriculture, General Motors and several foreign governments as well. She was called to discuss her inventions with the US Army secretary.

Breyenton's invention was a natural fertilising agent made with several strains of green and blue-green algae. The algal inoculant can be grown in solar heated vats or waste hot water from nuclear plants so that no extra energy is wasted on growing it. The inoculant provides plants with as much energy as synthetic petrol-based fertilisers. The algae can fix atmospheric nitrogen, just as certain bacteria do, but they do not need the co-operation of leguminous plants. The inoculant can be used with wheat, corn, lettuce, etc.

The sizeable amount of energy saved in the commercial manufacture can be put to other uses. Breyenton is still working out the details of commercial manufacture

Another advantage of this algal fertiliser is that it will not pollute the environment, as the chemical fertilisers do with their attendant run-offs. It enhances plant growth by increasing germination and growth rates and lowering disease rates. The teenage scientist is refining her work; meanwhile, she has applied for a patent for her inoculant

A PERPETUAL MOTION MACHINE AT LAST?

Efforts to develop one have been on for long. Two Californians have now applied for a patent on such an invention. Filed under the World Patent Co-operation Treaty (PCT) the machine developed by Robert and Edmund Kraus is "in perfect agreement" with the laws of physics as they stand today.

Their perpetual motion machine consists of liquid-filled triangular conduits, buried on the earth's surface under a large spherical mass object or an electrostatically charged surface. The spherical mass will generate different gravitational forces on the three conduits and cause the liquid to flow continuously the Krauses claim. This flow could be harnessed to drive a generator. In practice, the mass required to set the contraption going will be tremendous and the energy output small. However, the Krauses have put forward a series of calculations to show that the idea is feasible. Only closer inspection will tell if it really is.

SEND ANIMALS AS EMBRYOS

The day is not far off when a dairy farmer can get animals by parcel. Several laboratories need special strains of animals and lugging them across the world in cages can be cumbersome as well as time-consuming where strict quarantine exists. These difficulties have recently been overcome in a unique way.

Scientists from the Jackson Laboratory in Bar Harbar, Maine, USA, sent 200 potential mice to scientists in England where they were then grown in surrogate mothers. Their trick was to send them in the two-cell embryo stage packed in ampoules. The carrier tucked two ampoules in her blouse and two in her purse. The batch kept warm by the body heat produced 13 mice, whereas the batch carried in the purse produced only five.

METHODS OF INHERITANCE

Contrary to accepted biological theory, it appears that acquired characteristics can be vertically transmitted from parent to offspring. The Russian biologist Trofim Lysenko's experiment based on vertical transmission were a massive failure. Several other experiments which claimed to have shown similar success were later proved fraudulent. Now the theory of inheritance of acquired characters surfaces again with two recent findings. The first by two Canadian immunologists shows that acquired tolerance to foreign cells can be transmitted from father to offspring and grand offspring (in mice, of course). The second experiment by an American team shows that acquired susceptibility to ulcers was passed on from female rats to their offspring

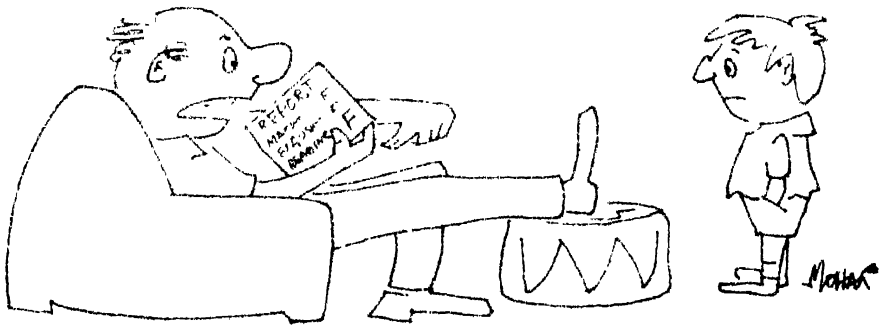
Reg Gorczynski and Ted Steele of the Ontario Cancer Institute, Canada, injected foreign cells (of strain B) into newly-born male mice (of strain A). Earlier experiments had shown that if foreign cells were injected into a newly-born mouse, the animal's body did not recognise the same as foreign later on in life In other words, it developed permanent tolerance to the foreign cells In the Canadian scientists' experiment the tolerance-induced male mice of strain A were paired with intolerant normal females of strain A. Over 50 per cent of their offspring were found to be tolerant to B cells In the next generation about 20 to 50 per cent of the offspring were tolerant of B cells. The researchers suggest that this transmission process could occur at the molecular level; it is probably the 'provirus' mechanism that is responsible.

The provirus mechanism proposes that nucleic acids move between cells as a part of the normal functioning of the organism. In the course of their movements, the motile nucleic acids might get inserted into genomes of the gametes. The process of insertion into the genomes is probably aided by the enzyme, reverse transcriptase. And as to how tolerance is infused in nucleic acids, there is an interesting answer That the body produces specific antibodies to each external stimulus is well known. When this happens, the corresponding antibody-producing cells also increase. The more the antibody producing cells the greater the chances of nucleic acids from them migrating into the gamete.

If this experiment can be reproduced, we'll need to revise the current theory of evolution which suggests that new species evolve by weeding out unsuccessful individuals

In the second study, N. J. Skolnick, S. H. Ackerman, M. A. Hoter and H. Weiner of the Albert Einstein College of Medicine, USA, induced ulcers in female rats by premature weaning. They separated a rat pup prematurely (at 14 days) from its mother and another after the normal 21 days. After the two grew up they were mated and half of each rat's litter was prematurely separated. All four groups were later checked for ulcer—80 per cent of the prematurely separated pups had ulcers. In the normally separated pups from the normally separated mother, only 19 per cent had ulcers, whereas in the normally separated pups of the prematurely separated mothers, 64 per cent had developed ulcers.

In an effort to see whether the transmission was prenatal or postnatal the researchers reared two prematurely separated and two normally separated female pups and mated them. After birth the litters were exchanged and then weaned naturally. The ulcer susceptibility of the pups born to prematurely separated mothers was much higher. And how does the American team explain this mode of transmission? They suggest that there might be some nongenetic method of inheritance of characters



"I insist, these are acquired and **not** *inherited!"*

For Rohini

On July 18, SLV3
India s experimental Satellite Launch Vehicle
successfully took off and placed Rohini in orbit
The filament wound motor cases for
the 3rd and 4th stages
the igniter motor cases for all the four stages
the polar wound pressure bottles
for control and guidance systems
and the structural backups for all the nozzles
employed fibreglass developed by us

fibreglass pilkington

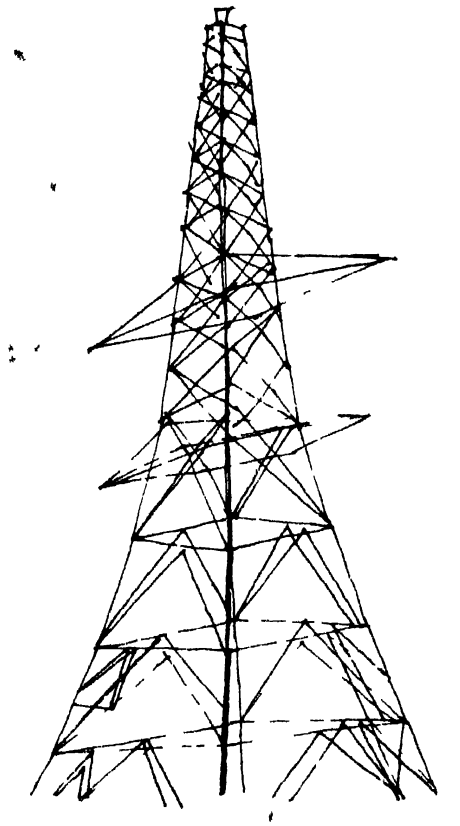
Regd Office 9 Wallace Street Bombay 400 001
Branches Ahmedabad ● Bangalore ● Bombay
Calcutta ● Delhi ● Madras

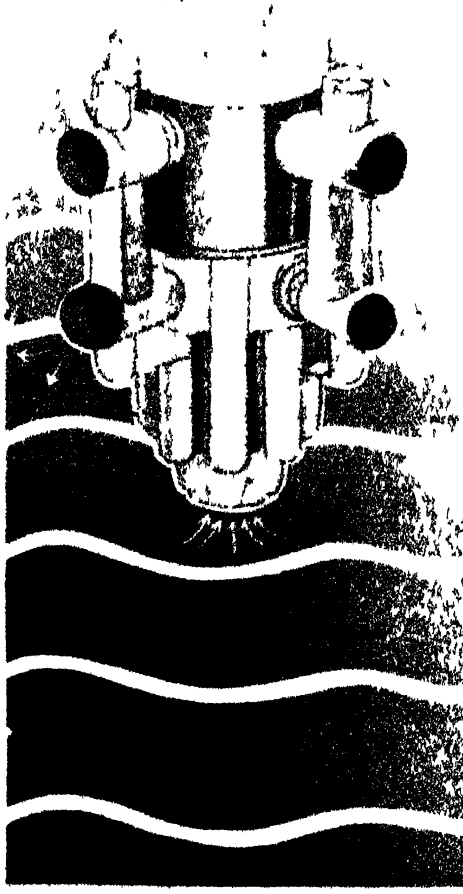
UKAFP180

Endless energy from the sea ?

S Z Qasim

Large floating power-generating plants continuously produce electricity from the sun via the sea





IT IS ONLY a few years since the world began to recognise the inevitability of an energy crisis. Right now the global oil needs are so large that much of the world is forced to surrender itself to the caprices of the Organisation of Petroleum Exporting Countries (OPEC). It is therefore not surprising why the search for alternative sources of energy to replace oil has become important.

Solar energy is thought to be the most promising source of the several alternatives at hand. It brings to mind heating panels or flat-plate collectors made of metal and glass on roofs of new and old houses. But solar energy in its widest sense supports almost all processes on earth and the oceans are no exception.

Of the many ingenious methods of drawing energy from the sea (see box page 20) ocean thermal energy conversion (OTEC) is an important one. The sun heats the oceans and its energy gets stored in the topmost layers. Below the surface, at a depth of about 1000 m, the temperature drops to a few degrees above freezing point. The temperature difference between the warm water at the top and cold water at lower depths is maintained by the sun's radiation at no cost to us. OTEC can use this thermal gradient for obtaining endless energy from the sea.

An old concept revived

OTEC is not a new concept. It was put forward by the French scientist, Arsène d'Arsonval, as early as 1881. In the late 1920s a student of his, George Claude, first demonstrated the feasibility of the idea of an OTEC plant using a barge in the Mediterranean Sea. In 1930 he built a small OTEC plant in Matanzas Bay, Cuba. Unfortunately, the Cuban plant was destroyed by a storm. Since oil was cheap and abundant till a decade ago, the idea of OTEC plants remained in [illegible] for a long time.

[illegible] an OTEC plant is simple. A "working fluid" like ammonia or propane with a low boiling point is pumped into a closed tube exposed to the warm water zone. The heat of the warm water first vaporises the working fluid. This vapour is then taken to the colder water zone where it condenses to give back the working fluid in liquid form. If this vapour is allowed to expand through a turbine on this return journey it can turn a generator. The vapour leaving the turbine is channelled into a condenser at the lower temperature of the cold water zone. The condensed liquid is pumped into a boiler-evaporator to start the cycle afresh. A diagrammatic representation of its working principle is given in Fig. 1 on page 18.

After Claude's 1930 experiment, the growing awareness of the energy crisis once again brought OTEC to the attention of scientists. Two Americans, J Hilbert Anderson and his son James, improved upon Claude's design in the late sixties. On 8 May 1975, father and son wheeled a box-like three-metre high structure studded with many coloured bulbs and spotlights to the Shamrock Hilton Hotel in Houston, Texas, USA. The occasion was the third OTEC workshop where amidst the thunderous applause of a large number of spectators they switched the system on with a sudden glow of multi-coloured light bulbs. Andersons' model for generating power from "the sun via the sea" consisted of the working fluid propane (refrigerant R-11) circulating into the box-like structure containing a boiler, a small vapour turbine, a condenser, an alternator and two tanks, one of cold and the other of warm water.

The demonstration given by the Andersons was undoubtedly a feat of engineering, although only on a small scale. Their model was built from a modest grant from the National Science Foundation of USA and had a generating capacity of about 200 watts. Nevertheless, it gave a visual and valid demonstration that the thermal variation between the different levels of the oceans could be used to generate power.

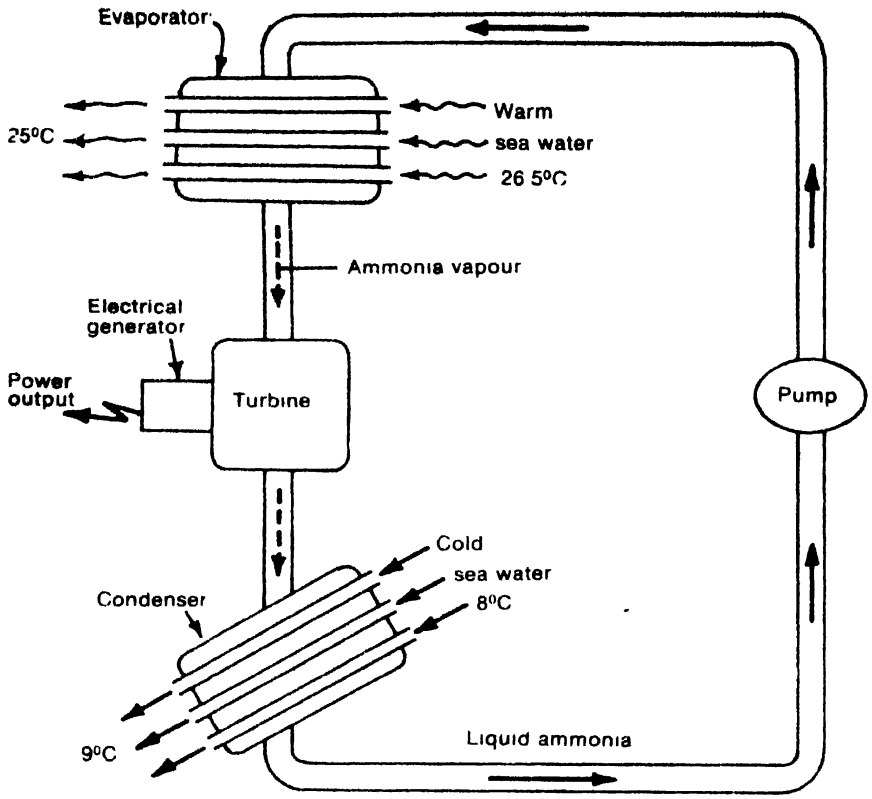


Fig. 1 Concept behind OTEC plant Working fluid (liquid ammonia) is pumped through the heat exchanger (evaporator and condenser) and its functions are regulated by the warm sea water (26 5°C) taken from the surface and cold sea water (8°C) pumped from deeper layers



Arsène d' Arsonval, the French scientist (1851-1940), who pioneered the concept of ocean thermal energy conversion

Warm surfaces and cold depths

The temperature difference between the different depth levels of the oceans is a very important factor in any OTEC plant. The first OTEC workshop held in June 1973 at Pittsburgh, USA, names maximum gradients and maximum differences in water temperature with depth, and large volumes of sea water supply as important factors in locating an OTEC plant. Such geographical locations are mainly in the tropics or in the Gulf Stream zones. Indian waters are among the suitable locations. Fig.3 on page 19 illustrates this by the example of sea-temperature profiles in the Arabian Sea and the Bay of Bengal. Fig. 4 on page 20 shows that such regions form a very big part of the oceans.

Even in the tropics, though, the temperature difference is not more than around 20°C. This brings down the thermodynamic efficiency of the process, which is dependent on this temperature difference, to about two and a half per cent. This has been regarded by some critics as hopelessly low. In a conventional heat engine, indeed, this would be hopelessly inefficient. However, we must keep in mind that the energy for the process comes free of cost. The low efficiency can be overcome by using a much larger size of the heat exchanger and a proper choice of working fluid.

Scientists and engineers in different parts of the world are now working on the design and feasibility of such plants. Most of these plants operate on what is called a closed-cycle OTEC. Closed-cycle plants use a working fluid different from sea water. Two large US companies—TRW Inc. and Lockheed Missiles and Space Company—are at present busy finalising their designs.

The designs resemble huge underwater colonies. The TRW proposes a 17-storey, 100 MW plant with four power modules. These modules are very large concrete cylinders going down into the sea up to a depth greater than 500 metres. The platform of the plant extends above the waterline and is equipped with a helipad and loading and unloading facilities. Lockheed's design also contains four power modules with a telescopic cold water pipe and is capable of generating 160 MW.

Both the designs make use of ammonia as the working fluid. A proper heat exchanger consisting of evaporator and condenser is an important part of an OTEC plant design. The heat exchanger comprises many tubes through which sea water flows, while the working fluid and its vapour flow outside the tubes. The small temperature difference requires that the effective length of the heat-exchanger be very large. An example is a Lockheed design for a single 25 MW modular unit. It needs 900 km of two-inch (5 cm) tubing made of either aluminium or titanium!

Besides the American companies, Japan and the newly created consortium of European countries are also busy developing newer, and probably cheaper, designs of OTEC plants. Most of these floating underwater colonies will be manned by officers and crew who will have to be provided with living accommodation at the plant. Helipads and supply ships will maintain contact with the shore.

The designs available today are largely those of anchored plants, either offshore or near the coastline. A new type of floating factory is now under development. It is called an "ocean grazing plant" and from season to season it can move to areas with greatest temperature advantage. Satellite imagery is being used to map such locations and plot the movements of ocean grazing plants.

Problems and constraints

The nature of the heat exchanger is the most critical factor in the efficiency of OTEC plants. Copper, with its high conductivity, is the ideal metal for low temperature differences in heat exchangers. The metal, however, is known to be toxic to marine life and there is a possibility that its large-scale use might cause destruction of

marine fauna around an OTEC plant which in turn could disturb the equilibrium of the food chain in surrounding waters. The metals now being considered are aluminium and titanium. Aluminium is the lighter and cheaper of the two but is expected to have a shorter design life.

Corrosion can cause leakages and can, together with fouling (formation of slimy layers by marine organisms clinging to the surface of the heat exchanger), seriously impair the efficiency of heat transfer. Cleaning methods are being developed to overcome this problem. Continuous mechanical cleaning, fouling-retardant metals and chlorination processing of the system are a few of the methods now under test. The most economical metals for the construction of heat exchangers are being tested off the Hawaiian coast. Sea water is being run into a bundle of seven tubes made of different metals and the impact of biofouling in each is being monitored.

The cold water pipe, through which the seawater from deep layers will be pumped, will be very long and have a very large diameter. Some idea of the size of the problem can be had from the results of the analysis reported by Lockheed and TRW in the spring of 1975. For a 250 MW plant, they estimate that the cold water pipe will have to reach a depth of upto 1000 m and may perhaps have a diameter of 30 m. The effective water flow through the pipe would amount to nearly one and a half million litres per second, which is comparable to the average flow of the largest rivers in the world! The transport and assembly of the cold water and heat exchanger pipes will pose unprecedented problems of scale. Safe and economical methods are being studied to solve them. The telescopic design developed by Lockheed considerably shortens the length to be assembled at sites.

The environmental impact of the huge amount of waterflow is naturally expected to be significant but not serious. The second OTEC workshop held in September 1974, at Washington, USA, considered and included environmental impact analyses for locating the plants. The exact environmental impact of OTEC plants is still unclear but protagonists are aware of the problems.

How economic is OTEC?

Comparative costs of OTEC in relation to conventional power sources are available from the American studies. At present the USA has the largest programme on OTEC. Government funding for OTEC in the USA increased from $ 700,000 (about Rs 55 lakh) in 1974 to $ 56 million (about Rs. 44 crore) in 1978. Since 1973, Japan and the consortium of European countries have also been heavily involved in research on OTEC.

This year, a 50 kW OTEC plant designed by Lockheed, is scheduled for operation off the island of Hawaii. The baseline cost worked out by Lockheed a few years ago includes an investment of $ 2600 (Rs. 20,000) per kW and a power cost of 3.6 cents or about 28 paise per kWh.

The total power cost of conventional power sources for the USA has been quoted as follows; oil - 3.2 cents (about 25 paise) per kWh; coal—2.5 cents (about 20 paise) per kWh; and nuclear fission—2.6 cents (about 20 paise) per kWh. In comparison the total power cost of OTEC plants, at 2.7 to 3.6 cents (about 21 to 28 paise) per kWh, stands a little higher than conventional power sources.

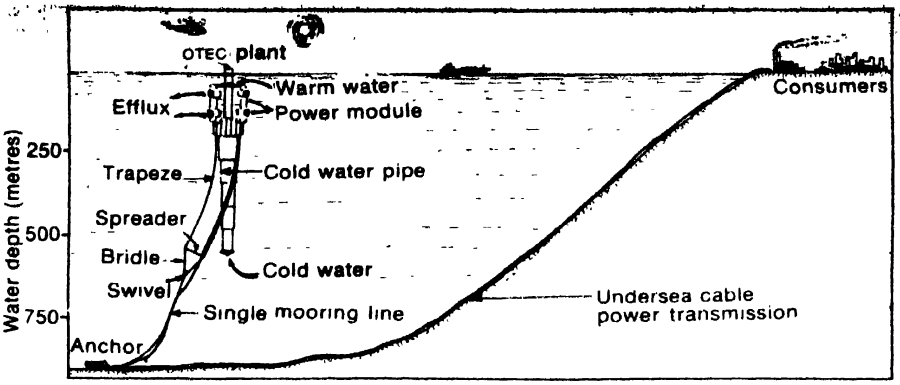


Fig. 2 The deployed Lockheed OTEC system in the operating temperature regime of the sea The power generated is transmitted through the undersea cable to the shore

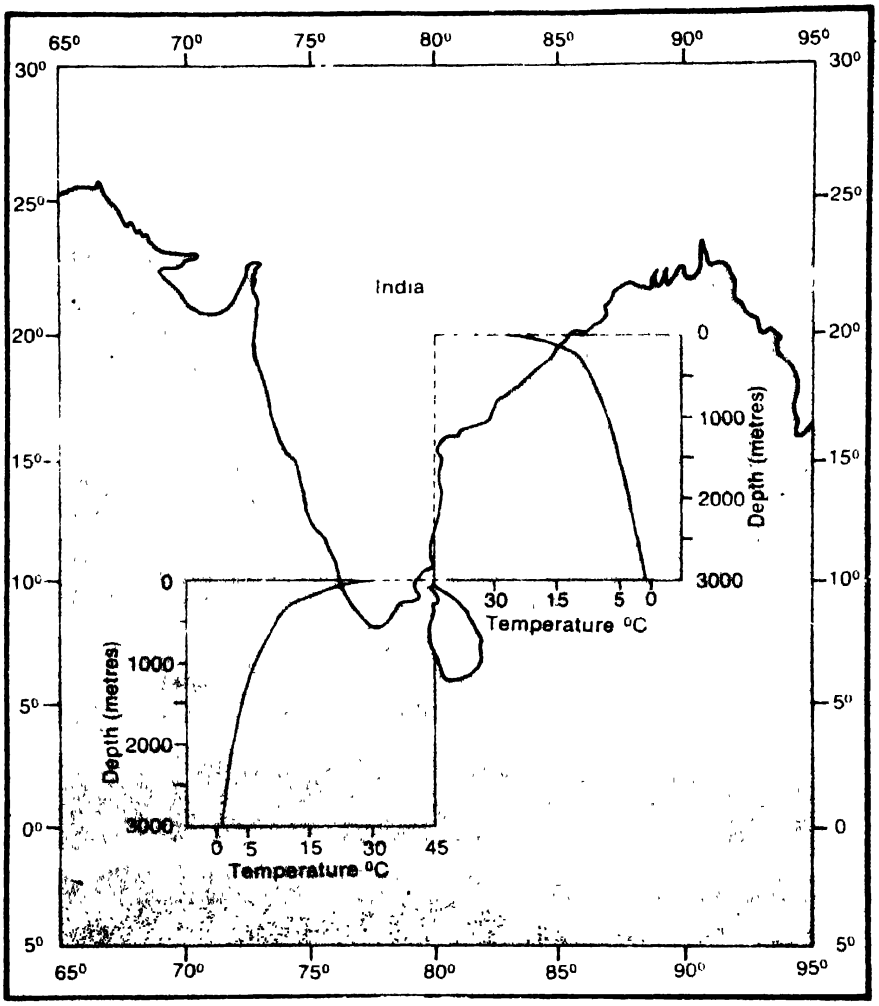


Fig. 3 Average vertical profile of temperature for two 10° squares (0°-10°N and 78-80°E) in the Arabian Sea and (10°-20°N,80°-90°E) in the Bay of Bengal The temperature regime of almost the entire coastline of India appears to be suitable for OTEC plants

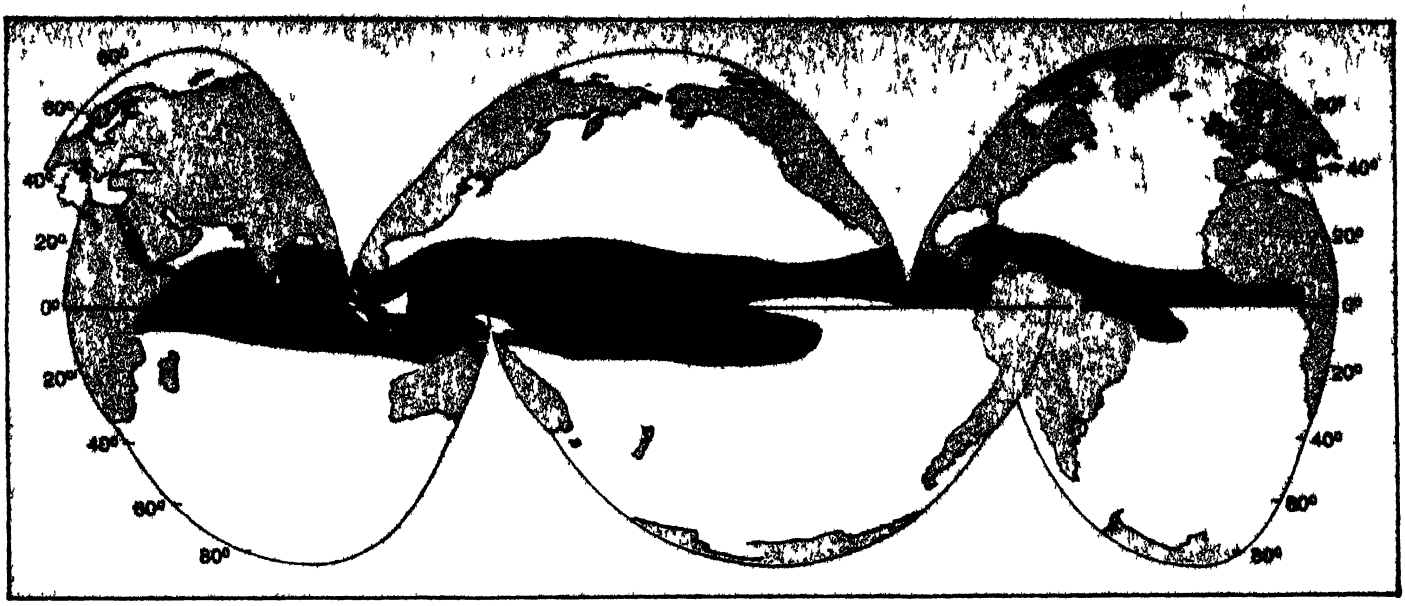


Fig 4 Regions of the world-oceans with an average surface temperature of 25°C The shaded area accounts for nearly 20 per cent of the total ocean surface and lies between the Tropics of Cancer and Capricorn

Oceans have many sources of energy.

OCEAN thermal energy conversion is but one method of obtaining energy from the sea There are at least seven other equally ingenious methods Energy can be obtained from ocean waves, tides and tidal currents, ocean winds, ocean currents, salinity gradients, ocean geothermals and kelp bioconversion Each of these methods provides renewable sources of energy They do not involve either the environmental and waste disposal problems generally associated with power plants using conventional energy sources or the special security problems associated with nuclear energy

Tides—energy from "the sun and the moon" via the sea

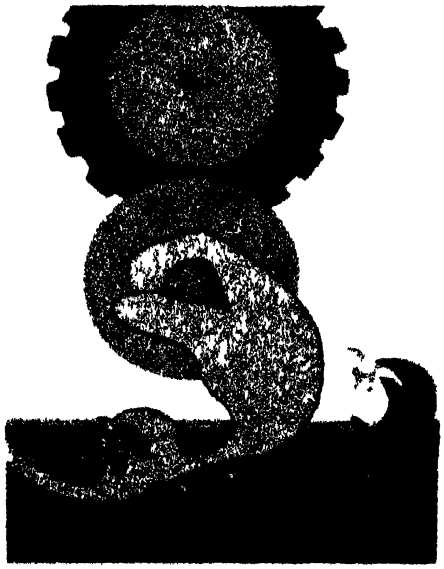
Perhaps the most popular and feasible of the other methods is that of producing energy from the tides Tides are much more stable than the seasons The powerful and regular ebb and flow of the tide is produced by astronomical gravitational forces of the sun and the moon If the difference in low-tide and high-tide is large and either natural or artificial mechanisms of water-storage are available, tidal energy conversion is quite feasible The total global estimate of tidal power however is only 2 per cent of the world's potential hydroelectric capacity The tidal range is large only in some areas and those identified so far include the La Rance estuary in France, the Severn estuary in the UK, the Bay of Fundy in Canada, the White Sea and the Sea of Okhotsk in the USSR and the bays of Cambay and Kutch in India

At present, a commercial size tidal power plant is in operation on the La Rance estuary in France The plant, commissioned in 1966, produces 230 MW of power There are also a number of small tidal power plants operating in China The Chinese power plant at Taliang, for instance, has a capacity of 144 kW and was probably completed as far back as 1958 Another experimental power plant is in operation at Kislava Guba in the Barents Sea in the USSR Tidal power plants are also under consideration in the Severn estuary, the Bay of Fundy, and in some areas of Argentina A preliminary study conducted by the National Institute of Oceanography (NIO) indicates that certain areas in Gujarat and West Bengal are also very promising for tidal power plants Regions in which the tidal range is suitable are few India is fortunate in having at least two such regions

Even though the total potential of tidal power is small, tidal power is important for its stability in comparison with hydroelectric power which is very dependent on the seasons It is also important because it is renewable and can therefore save exhaustible fossil-fuel resources

Bobbing waves work for man

The ebb and flow of tides is a regular but long-period motion Besides this, waves keep the surface waters of the oceans in continual motion This continual motion can also be harnessed to produce energy The vertical rise and fall of successive waves is used to activate either a water-operated or air-operated turbine. Another method of working the turbines uses the to-and-fro rolling motion of the waves In a third method, waves are concentrated in a converging channel and the breaking waves maintain a head of water whose concentrated momentum can drive a turbine



Wave-activated turbine generators (WATG) have been in use for more than a decade but each unit generates a very small quantity of electricity However, multiple-WATG units have been proposed and these appear to be quite promising

Perhaps the most popular of WATG designs is the Salter duck It has earned its name from the 20 to 40 vanes or cams which bob up and down by the rolling action of the waves Through non-return valves these ducks convert the rolling motion and turn a turbine The cost is rather high but is continually being brought down In 1978 the average estimated cost was as high as Rs 3 46 per kWh but advocates of wave-power in UK now maintain that it can easily be cut down to about Rs 1.73 per kWh Dr Salter of UK claims that efficient designs could bring the cost down to about 70

Production of electric power and its transfer to the shore by cable may involve slightly higher costs if energy from OTEC is used. But this problem has an interesting solution. The alternative integrates a variety of industrial activities at or around the plant site with OTEC energy.

Broadly speaking, three types of industrial activity can be combined with OTEC plants. The cold sea water from an OTEC plant is rich in nutrients. This nutrient-rich water could be used for aquaculture or for a rich production of fishery near the plant and in the surrounding areas. The abundantly and freely available air and water around the OTEC plant could be processed into valuable and transferable products like ammonia and liquid hydrogen. Finally, raw material needing energy-intensive processing could be brought to OTEC plants and processed at site. Desalination, alumina processing and aluminium production are some of the important examples. Fig. 7 on page 23 gives an outline of the various possibilities of combining industrial activity and OTEC.



Fig.5 The Salter duck Dr Andrew Salter's design makes use of huge vanes bobbing up and down by the motion of the waves The bobbing of the vanes is converted to electricity

Technology is not the problem

All those involved in OTEC research and development believe that no scientific or technical breakthroughs except those of scale are now required for the construction of large OTEC plants. J. Hilbert Anderson, who demonstrated the viability of OTEC in 1975, believes that "We should be building sea thermal power right now". Economics, not technology, is the main factor holding back OTEC

paise per kWh but other experts are doubtful.

The NIO in India, has developed a wave-powered oscillator which is undergoing tests and further refinements. The potential amount of power that can be generated from waves is still not very clear but an estimate by British scientists indicates that it is possible to generate about 50 kW per metre.

Weeds give fuel and food

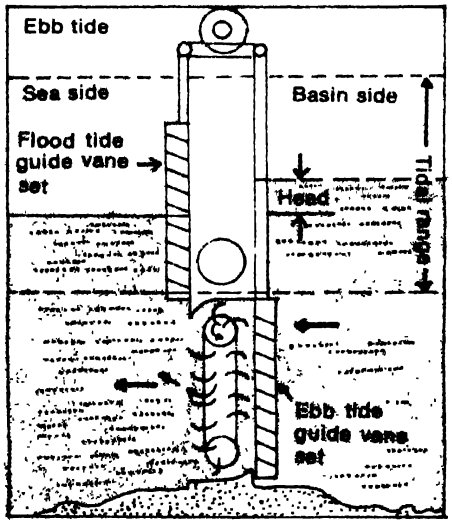
It is not necessary to think of energy from the sea only in a mechanical form. Bioconversion reduces the intervening mechanical parapharnelia. It is based on the simple but elegant principle that seaweeds, which convert solar energy by photosynthesis, can be processed to yield fuel, food and industrial products. Thousands of hectares of readily available ocean surfaces can be converted to marine farms for the cultivation of seaweeds to produce economically viable power and by-products.

Rapidly growing and easily harvestable giant seaweeds like Kelp (*Ecklonia, Laminaria* and *Macrocystis*) are cultured on lines or nylon ropes in the open ocean or in suitable areas of coastal waters. The lines are then transported to a processing plant where the sea-weeds are clipped without damaging the plant. The lines with the mother plants are returned to the sea for further growth. Each line can be harvested four times in a year. If seaweeds are on fixed or large submerged substrata, a harvesting ship is used. In the processing plant the seaweeds are converted into methane, food and fertilisers. The growth of seaweeds can be accelerated by fertilising the water with nutrients or by pumping nutrient-rich water from the deeper layer of the sea.

Kelp is not found in tropical waters. In Indian conditions warm water seaweeds like *Sargassum* are thought to be suitable for bioconversion Recently the importance of marine algae for pharmaceuticals has also been recognised. A recent report of the NIO on the marine algae resources of the Maharashtra coast estimates that the total annual seaweed production of the Maharashtra coast alone would be of the order of 3000 tons even on a dry weight basis.

Besides these main sources, several other ways of tapping the wealth of the oceans are under study. One such study concerns a pilot salinity power station in Sweden with a generating power of 200 MW. If a semi-permeable membrane is placed between two salt solutions of different concentrations, then there is a natural movement of ions through the barrier until both sides are equal in concentration. This is the principle of osmosis and the movement of ions can cause an electrical current. Salinity power uses the concentration gradients of salts in the sea to generate electricity.

There have also been proposals for extracting useful power from the great ocean currents which sweep the coasts all over the earth. The designs are simple but the main problem is their low-energy density. Even some of the swiftest of currents in the equatorial regions have low-energy densities. Proposals have also been put forward to use the tremendous amounts of energy trapped as latent energy in ice, which forms three-fourths of the world's fresh water.



Harnessing tidal power. Lift translators have vanes to guide liquid (or air) flow to a rotary device turning a generator. The tidal version has two sets of vanes. Depending on the direction of flow (ebb tide or flood tide) one or the other is lowered. The figure shows a schematic view of the device at ebb tide. At flood tide, the flow is reversed and the other set of vanes guiding the flow in proper direction would be lowered

Are we going to remain land-bound?

Man, in his search for energy sources, has so far been very much a land-bound animal. This confines his search to a quarter of the earth's surface. All of the other three-quarters of the earth's surface is covered by water, or ice. The oceans are a vast store house of renewable energy that is waiting to be unlocked. This is also important for India. The advantage of our position is that it may be possible for us to plan our energy needs in a manner which avoids heavy dependence on exhaustible energy resources like oil and coal and concentrates on using as many renewable resources as possible. It is time we looked out—to the sea.

S. Z. Q.

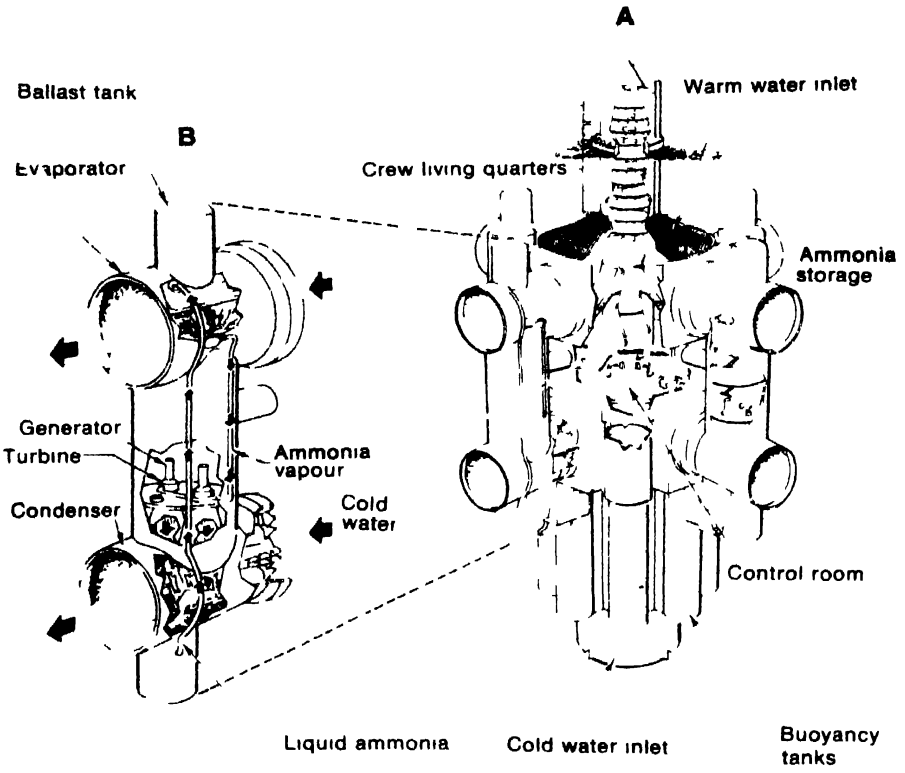


Fig 6 Under water colony The plan for a Lockheed designed offshore manned OTEC plant A in the figure gives the major elements of the main plant B indicates the details of a module

development today The largest conference ever held on OTEC met in February 1978, at Miami, USA Not only were Third World countries from tropical seas represented, but even officials from OPEC were present since they know that their oil reserves cannot last indefinitely

However, the biggest questions that are yet unsolved are political and not really economic Many countries have not yet declared their Exclusive Economic Zones in their waters The problem is to operate without infringing the political boundaries The main political question which remains to be thrashed out is, how should Exclusive Economic Zones be regulated and taxed?

In spite of the small economic disadvantage presently suffered by OTEC plants in comparison with conventional power sources, they clearly indicate the possibilities of economically utilising the earth's *renewable* sources of energy The OTEC power plants can operate round the clock, will not incur fuel costs and are totally self-supporting They have no adverse effect on the marine environment and minimum objections have been raised to their installation by ecologists They will be no less safer to operate than the large offshore oil structures and oil platforms

OTEC plants will provide maximum security and reliability in producing power at a price fairly comparable to that of existing power generation plants using conventional sources OTEC plants are presently being planned for tropical seas where the temperature difference is large But once high efficiency heat exchangers develop, smaller and economical plants will be possible for a wide range of potential locations Integration of industrial activities with the plant and the development of ocean grazing plants will overcome the effects of seasonal changes and will provide maximum efficiency and safety

In spite of the suitability of the Indian waters for OTEC, Tamil Nadu is the only maritime state which has recognised that OTEC could possibly be an ideal substitute for the conventional methods of energy production in India In February 1979 the chairman of the Tamil Nadu Electricity Board requested the National Institute of Oceanography (NIO), Goa, to provide baseline information on a proposed OTEC plant to be set up off the Tamil Nadu Coast Four sites were considered for technical feasibility

The development schedule of OTEC needs the study of large oceanographic components to select the best site under all weather conditions It needs precise determination of temperature and salinity profiles along many stretches of the coastline in different seasons and a detailed knowledge of meteorological conditions,

OTEC in India

THE TOTAL power generation potential for OTEC plants in India is estimated to be quite high. It would largely depend upon the size and number of plants deployed along the Indian coastline Since the southern parts of both the east and west coasts of India appear to be very suitable from the point of view of thermal gradient in the sea, it is possible to go on adding one plant after the other to meet our increasing energy demands. Each OTEC plant could have between 25 to 50 MW capacity and we can easily add more plants according to our needs. Smaller plants can be designed for the Andaman and Lakshadweep islands

The total power generation capacity in India, estimated in 1978 was 25,060 MW Of this, thermal power was estimated at 14,184 MW (about 57 per cent of the total), hydro-electric power at 9,773 MW (about 39 per cent) nuclear power at 620 MW (about two and a half per cent) while diesel and gas based power was estimated to be purely nominal By contrast a Tamil Nadu Electricity Board (TNEB) spokesman estimates that the Tamil Nadu coast alone could sustain OTEC plants of 10,000 MW capacity

Nor are the cost considerations very unfavourable OTEC power has been estimated to cost about 21 to 28 paise per kWh according to the US estimates The present costs of power generation in India have been estimated at 25 to 35 paise per kWh for coal-based thermal plants, 13 to 16 paise for hydro-electric power, 17 to 20 paise for nuclear power (based on figures for the Tarapur plant and the Rajasthan Atomic Power Plant-1) and as high as 95 to 110 paise per kWh for diesel and gas based power generation OTEC power, according to present US estimates, comes out cheaper than coal-based thermal plants operating in India

We now have an opportunity to test the viability of OTEC plants in India The OTEC plant proposed by the TNEB has received a green signal for the preparation of a project report It involves technical collaboration with the General Electric Company (GEC) of the US and the details of the project report will be finalized in consultation with GEC

The plant is to be located near Kulasekharapattinam, a small port in the Tirunelveli district of Tamil Nadu It will initially have a capacity of 25 MW and the project will cost about Rs 80 to 100 crore. It will be a closed-cycle type plant and will use ammonia as the working fluid and draw cold water from a depth of 1000 metres. Submarine cables which will carry power to the shores, would account for Rs. 20 crores, a substantial part of the project cost.

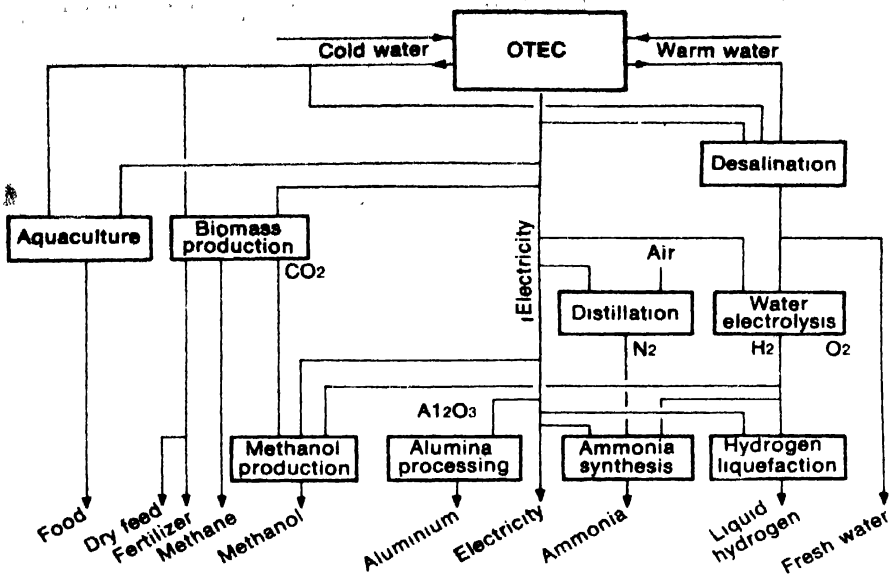


Fig. 7 Alternative industrial possibilities of OTEC plant. The power generated can be used on-board the plant to make energy intensive products such as ammonia, methanol, aluminium, liquid hydrogen, fresh water. The cold nutrient-rich water when brought from deeper layers to surface layers will increase the fertility of water for aquaculture and natural fisheries

Mushrooming open-cycle OTEC gives drinking water

MOST OTEC designs are of the closed-cycle type. They have their disadvantages; they use a working fluid that is different from sea water. The working fluid commonly used is ammonia, which is known to be poisonous, and must not be allowed to mix with the outer sea water in the heat exchanger. This means safety measures, and a very high degree of accuracy which naturally makes designs more difficult and costly. Accidents, though design can take care of them, could pose grave hazards.

Open-cycle designs using sea water itself as the working fluid, though attractive, have their own problems. The very low surface water temperatures mean that sea water will have to be evaporated at temperatures under 30°C, well below its boiling point. Evaporation under vacuum is not in itself an insurmountable problem. The real problem lies in the enormous steam volumes which would result. Such tremendous volumes cannot be easily handled by conventional turbines. Design engineers prefer a working fluid, like ammonia, which has a boiling point well under the surface water temperatures. It can then boil at normal atmospheric pressures and the vapour volumes can be handled by conventional turbines.

A design, however, has recently been reported which takes care of this problem (*Chemical and Engineering News*, 28 July 1980, 58, 30, 28-35). The reported open-cycle OTEC design has been developed by J. Michael Wittig, a Westinghouse Electric engineer, for the US Department of Energy. The system has already passed computer simulation tests and a prototype is under serious consideration. The system, besides producing 100 MW of electricity, will produce 1.6 tonnes of distilled water per second!

Wittig's system draws the warm surface water into a flash evaporation chamber by vacuum suction. Only a very small fraction, about one half per cent, is flashed and the rest is returned to the ocean. The demisted steam from the evaporator operates a one-stage axial turbine. The cold ocean water brought to the surface condenses the vapour to give distilled water. Wittig claims that the system can use a conventional copper-nickel modular ring condenser. This would mean a higher efficiency of heat transfer because of the high conductivity of copper.

A giant mushroom shaped vessel houses the turbine. The vessel, about 100 m in diameter, can be made from prestressed concrete and will float on the water. The turbine, the novel feature of the design, consists largely of *helicopter blades*, about 14.5 m long. What about the large steam volumes from the flash evaporation? Wittig says that it need not be a problem any longer. Glass-fibre reinforced plastics can take care of the speeds and volumes involved. Interestingly, it was the aeronautical engineers who had already taken that problem into their stride in designing helicopter blades. What remained was to use them for turbines. Wittig, with his proposed prototype, has done just that and added fresh water to OTEC energy.

P. V. P.

configuration of the coastline and the conditions of the sea-bed.

Other important features that would have to be studied include the positioning of the plant, its interaction with the marine environment, and a systems analysis of the plant and its environment. There are five types of OTEC designs available in the world today to choose from, and as a starting point foreign consultancy will be necessary. But the goal will be to develop the best design suited to the conditions prevailing in the seas around India.

Self-sufficiency in energy is essential for a developing country like India. This seems to be quite difficult, at least in the immediate future, because of the rapid increase in the country's energy demand. We have also to learn from the advanced countries and their experience of conventional energy sources. It will be good, right from the beginning, to try utilising non-polluting, renewable sources of energy in preference to conventional sources. If we do this, we may not have to face the grave problems of energy and pollution the advanced countries are facing today.

The biggest constraint on the Tamil Nadu OTEC project today is lack of funds. There has been no allocation of funds whatsoever for any research and development work on OTEC in the country though this expenditure is only a small price for finding an alternative source for much-needed, renewable and non-polluting power generation. Our seas are a source of endless energy. The question is whether we have determination enough to tap it.



Dr Qasim, is at present the Director of the National Institute of Oceanography, Dona Paula, Goa. He has been deeply involved in the research and development in marine sciences in the country and is at present leader of a project on "Energy from the Sea". Dr. Qasim was also the Vice Chairman of the Advisory Committee on Marine Resources Research of FAO and the Chairman of IOC/UNESCO Working Committee on Training, Education and Mutual Assistance in Marine Sciences

Recommends reading.

1. Cohen, R. 1980 Energy from ocean thermal gradients *Oceanus*, Ocean Energy Number, **22**, 12—22 **2.** Haber, G. 1977 Solar power from the oceans *New Scientist*, **73**, 576—578. **3.** Richards, A F 1976. Extracting energy from the oceans. *Marine Technology Society Journal*, **10**, 5-24, **4** Trimble L. C., and R. L Potash 1979: OTEC goes to sea In *Proceedings, Sixth OTEC Conference*, Washington, D. C., June 19—22, Gordon Dugger, (Ed) U. S Government Printing Office.

For smoothness... for satisfaction...



GOLD
has no substitute.



Rs. 2.50 for 20
Local Taxes Extra

STATUTORY WARNING: CIGARETTE SMOKING IS INJURIOUS TO HEALTH

CASVS-228-234

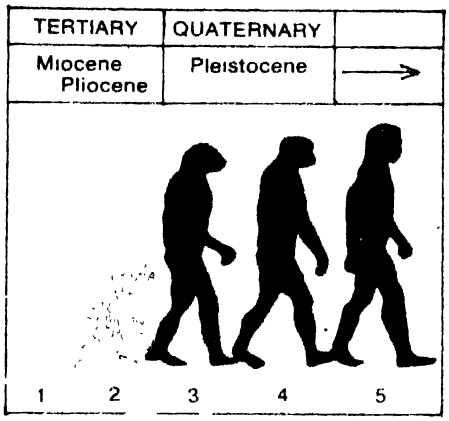
Main Dealer:—PUGAL DISTRIBUTORS, MADURAI-625001.

New light on the evolution of human bipedalism

MAN is essentially terrestrial and wholly bipedal (walking on two feet) in his habit. The refinements of the human walk are seen most clearly in the foot. In the course of evolution the foot underwent numerous modifications that were necessary for carrying the whole weight of the body. These modifications involved the development of the heel (which is a projection of one of the bones of the ankle), longitudinal as well as transverse arching of the tarsal (seven ankle bones) and the metatarsal region (five foot bones), a big toe which is in line with other toes, incorporated into the general mass of the foot, and a plantar surface constituting the sole of the foot.

Bipedalism, a major event in the evolution of man, would have provided the early hominids (man's ancestors) the advantages of a wider range of vision and freed the forelimbs for using tools and carrying food, that is, for grasping. The evolution of grasping forelimbs was an essential stage in the development of a large brain and human intelligence. At the same time, bipedalism has also resulted in many disadvantages, like the structural inefficiency of the spine and pelvic girdle. In a typical quadruped like a dog, the weight of the vital organs is evenly distributed along the backbone, like a suspension bridge. When this structure was upended, the backbone acquired a double 'S' curvature which is less efficient. More weight also has to be borne by the pelvic girdle now.

The hominid type of locomotor apparatus, that is the foot, presumably evolved from the generalised limbs which characterised apes of the Miocene (say 24 million to seven million years ago) the *Dryopithecines*. This limb structure was apparently an adaptation to the functional changes associated with the transition from generalised habits of swinging from the trees to bipedal progression on the ground. A big gap, however, existed in the palaeontological record between the extinct Miocene apes and the early Pleistocene (one million years to 40,000 years ago) hominids — the *Australopithecines* in whom erect bipedalism had reached an advanced stage of development. And till recently we also did not know when exactly bipedal locomotion became established in hominid populations.



The road to bipedalism: The drawings show a gradual progression towards walking erect on two feet (1) *Proconsul* a very early ape, (2) *Dryopithecus*: first of the fossil apes to be discovered. Man is considered to have emerged from this stock, (3) Advanced *Australopithecus*—having a bigger brain than his predecessor and a bipedal walker, (4) *Homo erectus*—first 'true man' of the genus *Homo* and (5) Early *Homo sapiens*—probably the earliest example of man's modern species.

The discovery of hominid footprints from the Pliocene Laetoli Beds in Tanzania, Africa, in recent months provided the necessary connecting link which objectively demonstrates the postulated phase of hominid evolution. Now, a study of some of these footprints by Professor M. H. Day and E. H. Wickens (*Nature* **286** 385) has shown beyond doubt that when these hominids walked they transmitted their body weight and the forces of propulsion to the ground in much the same way as modern man does. With the help of photogrammetry, a technique also widely used by surveyors and map-makers as a precision method of determining the surface form, these scientists compared fossil footprints of three individuals preserved in the volcanic tuff at the Laetoli site with those of modern man, made experimentally on the ground over wet sand of comparable consistency (0.30-0.6 mm grain size). The contour diagrams show the various depths that resulted from the differing pressures exerted on the ground whilst walking. The darker the colour, the deeper the impression. The contour patterns of fossil and modern human footprints are remarkably similar (Fig. 1). Specifically, impressions of the heel and ball of the foot are significant and it is seen that transfer of weight and force progresses from heel to ball, on the outer side of the foot. This constitutes the medial arch. This conclusively indicates that the Pliocene hominids at Laetoli had achieved a fully upright, bipedal and free-striding gait.

These Pliocene hominid footprints no doubt provide convincing evidence of early hominid bipedalism, especially when no fossil limb bones are known from the site. But, the importance of osteological and morphometric analysis of fossil bones in other situations cannot be underestimated.

SAMVIT KAUL.

Dr. Kaul is with the Department of Anthropology, Punjab University, Chandigarh.

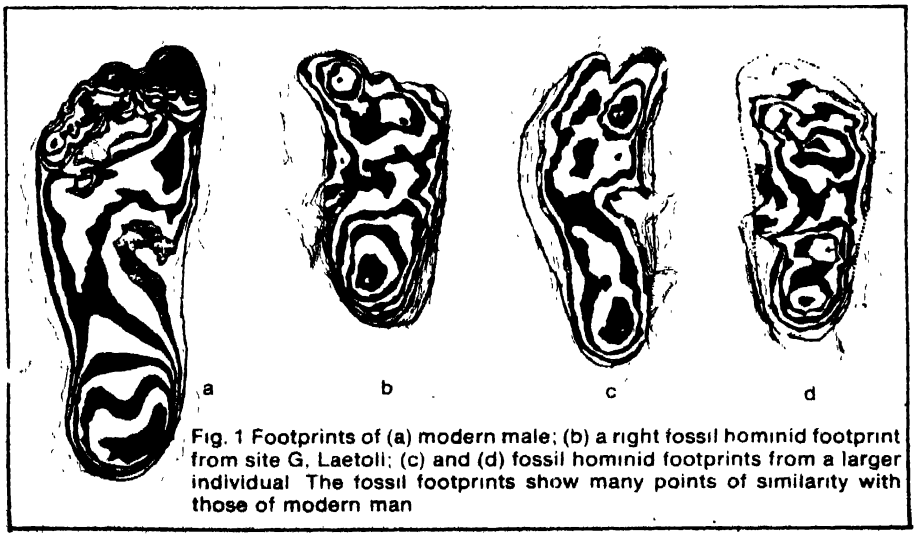


Fig. 1 Footprints of (a) modern male; (b) a right fossil hominid footprint from site G, Laetoli; (c) and (d) fossil hominid footprints from a larger individual. The fossil footprints show many points of similarity with those of modern man.

Generating electricity through photosynthesis

PHOTOSYNTHESIS is probably the most efficient and economical process in nature for converting solar light energy into chemical energy and thereby synthesising complex organic molecules from simple molecules. In addition to the familiar green plants, many other eukaryotes such as green, brown and red algae and prokaryotes such as blue-green algae, green sulphur bacteria, etc, are known to depend on this process for their survival. The photosynthetic apparatus in eukaryotic cells is localised in chloroplasts, while in the case of prokaryotes it is located in

the cell membrane or in vasicular structures called chromotophores. There have been many attempts in the recent past to understand the details of this process at the microscopic level and to generate photoelectricity by this process *in vitro*

The primary photochemical reaction in photosynthesis involves the transfer of an electron from a chlorophyll-donor species to an electron-acceptor molecule Te-Fu Ho, A. R. McIntosh and J. R. Bolton (*Nature* **286**, 254) have studied the effect of visible light on a synthetic porphyrin (P) linked to a quinone (Q) by a hydrocarbon chain. The porphyrin part of this molecule resembles chlorophyll and the quinone part is similar to the electron acceptor in the natural photosynthetic machinery From fluorescence quenching, ESR and flash-photolysis experiments, they have concluded that an intramolecular electron transfer from porphyrin to quinone takes place on irradiation with visible light Such a molecule will serve as an interesting and convenient model system to probe the details of photosynthesis Can we construct efficient solar cells using this type of molecule? Let's wait and see

In most of the early experiments, involving photoactive biological components in photo electric chemical cells, the electrode was coated with the active component embedded in liposomes or bi-layer lipid membranes Recently, however, A. Fredrick Janzen and Michael Seibert (*Nature* **286**, 584) have succeeded in coating a tin oxide (SnO_2) semiconductor electrode surface with a biological reaction centre complex. This method is simpler, and the active material is more stable and has greater accessibility to the electrode. The reaction-centre complex has been isolated from the purple, non-sulphur photosynthetic bacterium *Rhodopseudomonas sphaeroides R-26* It is a molecular complex of nuclear weight 80,000 to 100,000 containing three protein subunits and six chlorophyllous chromophores. The photochemical cell has been constructed with an SnO_2 electrode coated with the reaction-centre complex as the working electrode and an SnO_2 electrode as the counter electrode Using this cell, photovoltages up to 70 mV and photocurrents up to 0.3 micron ampere per centimetre square were observed in the external circuit when the electrolyte was 0.1 M Na_2So_4 and 0 05M hydroquinone in water or Tricine buffer (pH = 7 1), and the working electrode was illuminated with light of wavelength greater than 600 nm from a tungsten lamp. Theoretically, a maximum photovoltage of about 495 mV may be thus attained These electrodes will be quite useful in studying photosynthesis *in vitro* and may find important application in solar cells.

M. VASANTH KUMAR

Mr. Kumar is with the Chemical Physics Group at the Tata Institute of Fundamental Research, Bombay

DDT residues cling to the environment

DURING World War II, the first modern pesticide, DDT (dichloro-diphenyl-trichloroethane) was produced. Although DDT was first synthesised and described in 1874, its insecticidal properties were discovered only in 1939 by Paul Muller. It was extensively used in the wars to combat vector-borne diseases such as typhus, malaria and dysentery. During the first decade of its use, DDT saved almost five million lives and saved another 100 million people from severe illness. It appeared for a time that DDT could control most of the insect-borne diseases and also lead to better agricultural yields, as it is especially effective against agricultural pests. But today, owing to its slow degradation in the environment and its persistence and accumulation in the food chains, its widespread use is being questioned.

DDT, which persists in the environment, has a half-life (time required for one-half of a given material to undergo chemical reactions) of two to four years in the soil It may be biodegraded to its metabolite, DDE (1, 1'-dichloroethenyldene) bis—(4-chloro-) which is also persistent due to the presence of chlorinated aromatic group in the molecule. Several research workers have shown that pesticides, especially the chlorinated hydrocarbons (and their metabolites) have virtually spread over the entire earth It is estimated that there is almost a billion pounds of DDL in the world ecosystem;it is found in polar bears of the Arctic as well as seals in the Antarctic.

Recently J. J. O'Shea, W. J. Fleming III and E Cromartie (*Science* **209**, 509) report DDT contamination at Wheeler National Wildlife Refuge in the USA From 1947 to 1970 DDT was manufactured at a site leased by the US Army at Redstone Arsenal, Alabama. The production of DDT prior to June 1970, when manufacture ceased, had reached more than 6×10^5 kilograms Effluents from the factory ran directly into Wheeler National Wildlife Refuge where it joined Huntsville Spring Branch, a tributary of the Tennessee river about one kilometre from plant site This area of 140 km^2 is a major refuge for waterfowls with winter populations recently estimated at 80,000 ducks and geese However, in the past, population peaks of 150,000 were recorded

An analysis of sediments of Huntsville Spring Branch revealed DDT isomers and metabolites as high as 4×10^6 kilograms. In February 1979, the scientists collected fist-sized chunks of crystalline material lying near the plant site which had a DDT content of 21 per cent At the same time birds, rabbits and earthworms were collected for "residue" analysis from the plant site and also at a distance of 0.1, 0.3, 0.4, 0.5 and 1.0 kilometres from the factory. The concentrations of total DDT (DDT, its isomers and metabolites) in these fauna were high. Out of a total of 50 samples, in 37 of these, the residues in muscles of rabbits and birds exceeded the established tolerances for domestic animals for human consumption. The concentration of total DDT in whole carcass of female mallards was as high as 480 ppm (parts per million). Also, the eggs of these female mallards were found to be 10 per cent thinner and the overall productivity was found to be significantly lower than those of controls. These studies were undertaken nearly nine years after the manufacture of DDT was halted at the Alabama site



Nation-wide monitoring of pesticides (in the USA) in waterfowl wings since mid-1960 has shown that DDT and DDE concentrations in Alabama waterfowls are among the highest in the United States The residue levels in ducks killed by Alabama hunters were high enough to indicate impaired breeding According to the Refuge personnel, thousands of double-crested cormorants which used to winter at Wheeler are now rarely seen, bald eagles have not bred in the Refuge since the late 1940s; heron rookery, a mixed species showed population decline since 1950-51 In addition to the reproductive impairment implied by DDT residues, direct avian mortality due to DDT poisoning also seems possible. The earthworms collected at 0.1 and 0 3 km from plant site contained total DDT concentrations of 74 2 and 5.2 ppm, respectively, which do not imply lethality but exceed levels that were shown to impair reproduction in experimental birds

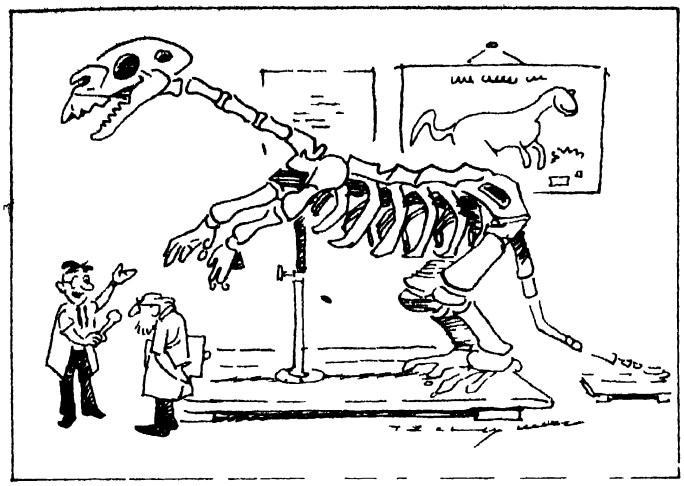
The Wheeler Refuge data shows alarmingly high concentrations of DDT in the environment even after a decade of cessation of DDT manufacture Very little was known about the effects of DDT on ecosystems at the time these disposal practices were initiated. This suggests the need for rigid safeguards and well-planned programmes for disposal of all forms of chemicals, in the interests of a clean environment.

S. A. BANERJI

Dr. (Mrs) Banerji is Associate Professor of Biochemistry at the Institute of Science, Bombay She is actively involved in the monitoring of organochlorine pesticide residues in foods available in the Bombay market.

This World of Science!

by R K Laxman



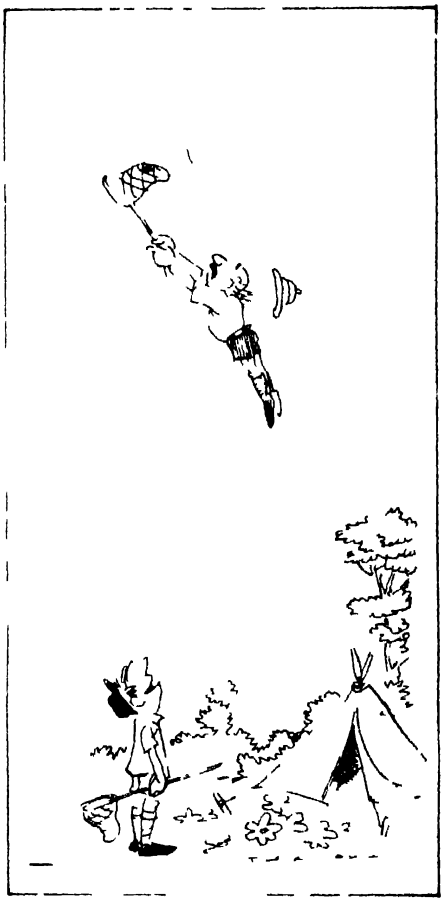
This piece doesn t fit in anywhere doc So it isn t a Dynopa plodiscoerus as we thought but a Dymonotorikyorous!



Let him go—no use holding down anyone unwilling to work here and wanting to emigrate



I m glad you like it here they give lots of funds and equipment and leave you alone to do what you like



Don t let it go professor Evidently you have caught a very rare butterfly

...and of scientists

A MEDICAL conference was held in Konigsberg in 1911 to discuss the effects of chemical No 606 which Paul Ehrlich (1854-1915) had declared to be effective against syphilis This chemical (dihydroxydiamino-arsenobenzene hydrochloride) was among the hundreds tried out by Ehrlich the founder of chemotherapy, in his search for a sleeping sickness cure, later it was named Salvarsan

Ehrlich reached the conference hall late and found its doors closed His knocking and shouting brought out a heavily built doorkeeper who angrily said, "What do you want... sir? Everything here is full up But the great immunologist did not let him close the door again and kept shouting, I must get in, I must get in! By now the din brought some organisers and senior doctors out Finding the door half open, Ehrlich sneaked inside

It is this obstinate little fellow who is determined to get in, the big uniformed man told them

One of the visitors recognised Ehrlich and rebuked the doorkeeper ' But that is a very great man that is Ehrlich himself

---

WHILE preparing a scientific lecture against atheism, a chaplain of Westminster Abbey sought Newton's help The scientist told him that God s existence was proved by the need for an 'initial impulse to set the planets in eternal motions around the sun ' About a century later, when Napoleon, like the chaplain, wanted to understand the scientific theory of the universe, Laplace told him his materialist hypothesis about how the solar system originated and added that this worked as the initial impulse "And where does God fit in?" asked the emperor Sire I had no need for that kind of hypothesis Newton needed it," the physicist replied

S N MUNSHI

Choose the pimple cream that not only treats pimples but helps prevent pimple scars



ESKAMEL*

pimple cream

ESKAMEL

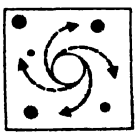
FOR THE TREATMENT OF PIMPLES AND ACNE

ESKAMEL*

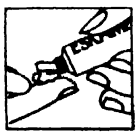


The pimple cream doctors recommend

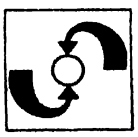
If you are not careful pimples can leave behind unsightly scars You can help by not touching pimples (even if you're itching to!) And by using Eskamel—the pimple cream that treats pimples and helps prevent pimple scars



Hands off! Pimples spread if pricked, scratched or touched.



Apply Eskamel over your face with damp cotton wool



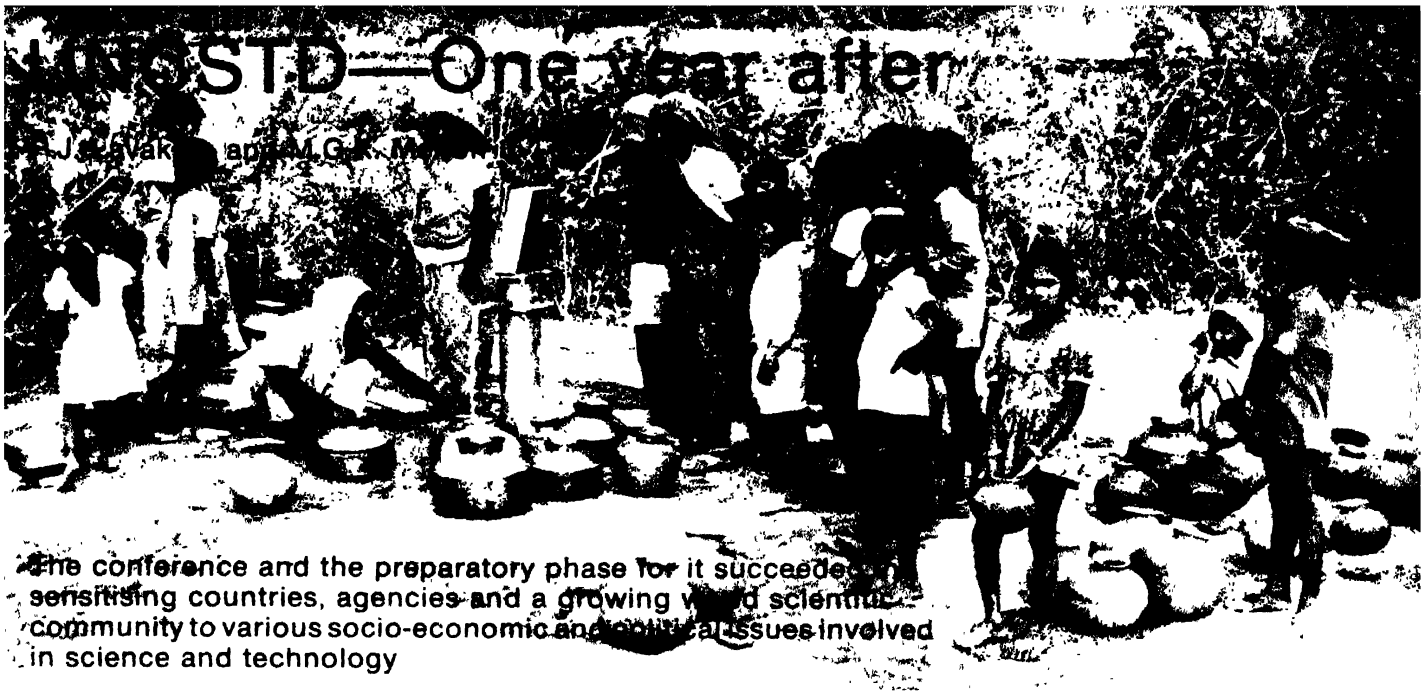
Eskamel has two proven ingredients that check infection, reduce skin oiliness and dry up pimples fast.

SK&F A Smith, Kline & French product.
* Eskamel is a Regd. Trade Mark.

LINTAS-ESK.2-2518

UNCSTD—One year after

J. S. Vakil and M. G. K. Menon



The conference and the preparatory phase for it succeeded in sensitising countries, agencies and a growing world scientific community to various socio-economic and political issues involved in science and technology

A YEAR ago, in August 1979, representatives of 142 member-states, the agencies of the United Nations, and a large number of governmental and non-governmental organisations assembled in Vienna for UNCSTD, the United Nations Conference on Science and Technology for Development. The purpose of UNCSTD was to discuss not the technical developments, but the socio-economic and political issues involved in science and technology becoming an essential part of the development process, and to define actions needed at the national, regional and international levels, particularly those by the UN, to ensure this.

Many in the scientific community were unhappy that a major UN conference relating to science and technology (S&T) would not be discussing scientific and technical matters, and that the participants would consist largely of political leaders, administrators, economists, planners, and others concerned with decision-making at the national and international levels, among whom many were no doubt scientists and technologists.

There is no denying the fact that the world we see around us, in its material sense as well as its value systems, expectations and social economic relationships, is largely a product of developments related to science and technology. Science had grown and declined in many earlier civilisations. But the present developments were *nucleated* in the presently industrialised countries of Europe. One has only to look at the developments that have taken place since World War II to realise the spectacular impact of S&T in the areas of industry, agriculture, medicine, transportation, communications, energy, defence systems, etc. But these developments have also resulted in great disparities between nations and classes of nations. It has also given rise to a feeling of euphoria that S&T is a magic wand that can bring about development.

It was somewhat in this spirit that, in 1963, a major UN Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas was held in Geneva. The conference sought to demonstrate the possibilities of accelerating development through the application of the latest advances in S&T. Though it was an intergovernmental conference, the emphasis was on the presentation of a very large number of scientific papers, documentary films, and the exhibition of several thousand books and periodicals on S&T. It was, therefore, more in the nature of a scientific congress, and it gave the advanced countries an opportunity to display to the developing countries the marvels they possessed. It was variously described as a "science and technology fair" or a "supermarket of science" where the items were available at a price to be defined by the sellers, including all conditions relating to the sale, and where the buyers (from the developing countries) were in no position to force an equitable transaction. Further, how were these buyers going to identify their real problems and select only the appropriate goods from this supermarket? Only with the aid of the developed countries, taking them (the developing countries) to a position of indebtedness and dependence rather than of self-reliance.

Since 1963, it has become increasingly apparent that the application of S&T for development is not merely a question of its transfer from an advanced country to a developing one. The primary problems relate to the growing and strengthening of the endogenous S&T capacities of the developing countries in a manner in which they become an essential part of development (with concomitant socio-political changes). While this has to be primarily a national effort, it is clear that it can be assisted considerably through an international understanding of what is involved, leading to the evolution of a code of conduct for international scientific relations (to prevent scientific colonialism); through mechanisms for transfer of technology that ensure that these are not one-sided but fair and equitable; through substantial international funding for catalysing and promoting the growth of such endogenous capabilities, bearing in mind that the primary effort and resources have to come from the developing countries themselves; ensuring a holistic approach through a co-ordinated and harmonised UN programme involving all its agencies which deal with different aspects and sectors of S&T and its utilisation; and institutional mechanisms to oversee and review these areas and programme of action. *UNCSTD 1979 was primarily directed towards these objectives.*

At the 1963 conference, a large number of scientific papers were presented on specific sectors of interest for development, setting out the existing knowledge in these areas; these were, for the first time, available in an organised and integrated fashion.

Such information would have been of infinitely greater value and impact if a base of endogenous capabilities had been set up over a large part of the world to appreciate, select from, absorb, own and adapt the relevant information

UN—ACAST

A positive outcome of the 1963 conference was the setting up, in 1964, of the UN Secretary-General's Advisory Committee on the Application of Science and Technology to Development (ACAST) a body consisting of specialists in different areas and from different countries, acting in their individual capacities ACAST was mainly expected to keep under review progress in the application of S&T to review the scientific and technological programmes and activities of the UN and related agencies and to advise the Economic and Social Council (ECOSOC) as to the need for making changes of organisation or other arrangements which would advance the application of S&T to development In the decade and a half of its existence, ACAST has produced a great deal of material of relevance for an appreciation of the patterns of development, needs arising from these developments in S&T and the manner in which these could be integrated with the development process The committee realised, right from the beginning that S&T could not be viewed in isolation, it had to be related to strategies for development

In 1971, a comprehensive document entitled World Plan of Action for Application of S&T to Development" was produced It identified the priority areas for research to develop new knowledge, skills and understanding, priority areas for the application of existing knowledge the need for building up endogenous scientific and technological capacity, and also gave certain suggestions regarding the implementation of the proposed plan of action which included the proposal for an international fund for these activities Apart from this, the ACAST set up in 1964, has carried out a number of studies on issues related to technology assessment, technology transfer, brain drain etc

The UN system was thus made sensitive to the need for a new kind of approach to S&T The ECOSOC decided that a special discussion on matters relating to S&T alone was necessary and it set up a Committee on Science & Technology for Development (CSTD) that met regularly It was this committee, which was enlarged to include all member-states of the UN that later became the Preparatory Committee for UNCSTD And it was this sensitising process, including the development of ideas relating to the proposal for a New International Economic Order (NIEO) that led to the holding of UNCSTD Indeed, the need for organising a global conference on S&T to reflect these aspects and concerns was discussed by ACAST, and ever since its twentieth session (1974) it was officially involved in the various aspects relating to the objectives, structure and agenda for what finally became UNCSTD

The New International Economic Order

In the immediate years after World War II, a large number of countries emerged from an era of colonial rule to one of political independence Political independence was, no doubt, an essential and necessary condition for the betterment of the lives of these peoples But political independence by itself did not bring about betterment of the lot of the vast masses of down-trodden peoples, nor did it improve their quality of life With political independence, the visible



In New Delhi a bullock draws a traditional cart amidst indigenously manufactured cars—development may call for a blend of the old and the new

signs of colonial occupation and control disappeared but a new form of dependence, far more insidious and much less visible, developed This was colonialism of a new kind, and directly a product of the way S&T had grown The increasing disparity in the field of S&T coupled with the monetary, legal and trading systems of the earlier periods that have remained unchanged and operate to the benefit of the better-off, brought about this situation

By and large, the developing countries have been, and continue to be, producers and exporters of primary raw materials, for which the price has always been, and continues to be, determined by the advanced countries But, in recent years they have become increasingly aware that they should carry out far more activities within their countries to transform primary raw materials to semi-finished or finished products—that is, they should industrialise It is for this reason that at the Lima Conference organised by the UNIDO in 1975, a target was set that the developing countries must attain a share of 25 per cent of the world industrial output by the year 2000 We have progressed just close to 9 per cent, but this might well be a reflection on the slower rate of growth which has occurred in the industrialised countries themselves

Although the developing countries account for some 3,000 million people, or three-fourths of the world's population, they are concerned with a mere one-fifth of the world's income The richer countries, with only a quarter of the world's population, account for four-fifths of the world's output It was against this image of an unequal world that the UN in May 1974, convened a special session of the General Assembly, and keeping in mind the spirit, purpose and principles of the Charter of the UN which was to promote the economic advancement and social progress of all peoples, proclaimed their united determination to work urgently for the establishment of the NIEO NIEO was to be based on equity, sovereign equality, interdependence common interest and co operation among all states irrespective of their economic and social systems and it was to correct inequalities and redress existing injustice, making it possible to eliminate the widening gap between developing and developed countries and ensure steadily accelerating economic and social developments and peace and justice for present and future generations

Recognising the role that S&T can play in achieving the objectives of NIEO the UN General Assembly decided, in December 1976 to hold a UN Conference on Science and Technology for Development during 1979

Preparatory phase

Formal preparations for UNCSTD began in early 1977 An early decision was that the conference and its preparations would essentially be of a governmental and intergovernmental character It was also decided that the primary documentation would consist of national papers submitted by the various member-states, which would have to be drafted according to specific guidelines approved by the Preparatory Committee at its First Session Additionally, regional meetings under the auspices of the various regional economic commissions were to formulate the common aspects relating to the different regions of the world These national and regional papers were to be considered by the Preparatory Committee for preparing a Draft Programme of Action, which

would be largely negotiated in the Preparatory Committee itself, and finally negotiated and approved at UNCSTD This process has been commonly referred to as the "ascending process" with the base formally rooted within the member states and their governments

At the national level, more than 125 countries out of the total of 151 UN members conducted a national analysis to outline their views and experience on the application of S&T to development Eleven regional meetings were organised during 1977-78 The intention was to involve, in each country, the governmental machinery, the scientific community, industry, professional associations, etc to arrive at the national paper It is true that, in many cases, such an interaction did not take place or was only marginal But isn t this a reflection of the reality obtaining in respect of the decision-making processes? Even in developed countries, to what extent is the scientific community truly involved in decision-making of a vital nature, affecting the country and, indeed, the world?

The national and regional papers received in the secretariat of the conference were consolidated and presented to the Third Session of the Preparatory Committee at the end of January 1979 Whilst there were very useful debates on this interesting document, which took up the entire time of the Third Session, the Group of 77 finally came to the conclusion that a different structure should be adopted for the draft programme of action and suggested that it should focus attention on three areas (a) strengthening the scientific and technological capacity of the developing countries, (b) restructuring the conditions for access to scientific know-how and technology as an integral part of the efforts to establish he new international economic order, and (c) improved coordination of scientific and technological activities within the UN system and an increase in financial resources for those activities

An ad-hoc working group of the Group of 77 met in New York to prepare a text of the Draft Programme of Action based on the above three areas This was then extensively negotiated with the developed countries during the Fourth and Fifth Sessions of the Preparatory Committee What emerged at the end of the Fifth Session in July 1979 was a negotiated text of the Draft Programme of Action to be submitted to the conference in Vienna for consideration Whereas some parts of this text had been agreed to, there were large parts of it, particularly concerning the crucial points on technology transfer, institutional machinery, financing, etc, that had been bracketed (that is, no agreement had been reached), in fact, within the text, there were suggested drafts corresponding to the position taken by various groups of member-states or individual governments It was this document which was finally discussed in Vienna This document dealt only with the horizontal areas namely the problematique of S&T for development It did not cover any sectoral areas



Shoe factory at Agra With labour surplus and shortage of capital in developing countries it can be unwise to replace men with machines

UNCSTD had a preparatory phase probably longer and more intense than any other UN conference It thus aroused very considerable interest and debate and did succeed in sensitising a very large number of decision-makers the world over regarding these important and complex questions It was not expected to perform a miracle not to be the end of a road It was meant to be an important milestone in a continuum of activities to increasingly focus attention on the development process, the objectives of the NIEO and the role of S&T in achieving these Since the follow-up phase will also be equally important as the preparatory phase UNCSTD has to be viewed in this framework

The growth of endogenous capabilities in S & T has to be based primarily on national efforts and the endogenous growth is a primary requirement for equitable global development and for attaining the objectives of the NIEO A great deal of discussion took place in the Preparatory Committee, and at UNCSTD, on the character of the national effort (recognition within the country by the decision-makers of the importance and role of S & T in development, allocation of necessary resources, infra-structural elements such as the education system, science policy aspects, etc)

In addition to the national effort, four aspects were discussed at Vienna where international action has a clear role to play in supporting and accelerating the national efforts These are: the importance of *international scientific co-operation*, when properly arranged and conducted, the relevance of *access to global information on science* on a rapid, inexpensive and easy basis (for which it is necessary to have national information systems connected to a network of information systems elsewhere including those in the developed countries, but appropriately organised to ensure minimum investment and a high signal to-noise ratio) the need for *coordinated and harmonious supportive effort by the UN agencies* and the need, therefore, for an appropriate machinery to ensure this and (whereas a large part of the finances required for the building up of endogenous S & T capabilities would have to come from within the country) an important promotional and catalysing role played through appropriate *international financing* in both magnitude and organisation

The above four issues were taken up at UNCSTD for major discussion, in their own right as well as with particular reference to their role in, and importance for, the rapid growth of endogenous capabilities in S&T in the developing countries

International cooperation in S & T

The various aspects involved in international scientific cooperation had been critically examined by a group of scientists from the Pugwash Movement at a meeting held in India The universal nature of science they said implies that scientific activities should be carried out on an open basis and therefore could involve collaborative international efforts In general, such cooperation demands roughly equal levels of capability amongst those involved Where this is not so, misunderstandings can arise, and indeed have arisen in the past

Taking note of the guidelines identified by the Pugwash group, the importance of international scientific cooperation, when properly conducted, for accelerating the growth of endogenous capabilities in S & T in the developing countries was accepted at UNCSTD It was emphasised that

cooperative activities should be planned to provide benefits to the partners on the basis of real mutuality. The cooperative programmes must take full note of development priorities determined by the developing countries themselves. Cooperative projects on problems of interest to the developing countries should preferably be carried out in the developing countries themselves with active cooperation from scientists from the developed countries. In the interests of global development, developed countries should devote more resources to the solution of problems relevant to the developing countries, and in doing so, through international cooperation, actively contribute to the strengthening and promoting of scientific and technological capabilities in the developing countries.

International information system

The headlong advances in S & T have resulted in the accumulation of a vast amount of knowledge; and this reservoir is being rapidly enlarged with the increasing tempo of research and development. If the existing and growing pool of knowledge is to be used effectively for development, it has to be managed in a way in which it is easily accessible, and available to all those who need it, with rapidity and at the lowest cost. Discussions at UNCSTD were concerned with the fact that the lack of effective means for utilising existing knowledge would be a limiting factor to economic and social development.

The conference noted that the various decentralised global cooperative information systems the various UN agencies have grown are all mission-oriented. There are two fully operational systems: INIS (International Nuclear Information System) of the International Atomic Energy Agency and AGRIS (Information System for the Agricultural Sciences and Technology) of the Food and Agricultural Organisation. The others are: Population Information System (POPIN), Human Settlements Information System (HSIS), etc. UNEP has set up an International Referral System referred to as INFOTERRA and UNIDO has established the Industrial Information System (INDIS) and subsequently the Industrial and Technological Information Bank (INTIB); the World Intellectual Property Organisation (WIPO) has the Patent Information Network (PIN). The United Nations Information System for Science and Technology (UNISIST) programme of UNESCO is the only information programme of a general nature providing a conceptual framework for the establishment of the national and international information systems and creating conditions for their world-wide interconnection. There are also data banks and information systems at national and regional levels, particularly in the developed countries.

However, the UNCSTD found it still necessary to discuss the matter relating to information systems for the following reasons. Firstly, there was the need to emphasise action at the national level if any international information system is to be effectively used. In general, when governments embark on the formulation of national S&T policies, the organisation of information systems for S & T is often regarded as a matter of secondary importance, and this has frequently led to a disorderly development of various information services in private bodies, public institutions, etc. It is only after a viable national S & T information system is established that one can approach an international system for information not available in the national system; it is important to define what you want to know and what questions to ask.

Major issues—Concepts relating to development

As a result of the debates in recent years, there is widespread agreement that development should not be regarded purely in terms of economic growth. It has many components, of which economic growth is certainly an important one. It is necessary to appreciate what the various aspects of development are, when one discusses the role of S&T in the development process. These aspects have been rather well brought out by Mr. Joao F. da Costa, Secretary-General of UNCSTD in the following terms:

(i) Development should be comprehensive: namely, it must transcend exclusively economic dimensions, to include social considerations such as the right kind of employment, promotion of creativity, safeguarding the rights of man, improved quality of life, etc.

(ii) Development should have endogenous roots and not merely imitate models. Consequently, styles of development should be diverse and respond to locale-specific economic and social structures as well as natural and human environment and cultural identity. This would make the world a more interesting place rather than a monolithic faceless entity. This also implies that while the need exists to reduce the present sharp contrasts in the standards of living, the so-far-held limited concept of a "gap" between countries, defined narrowly and somewhat negatively in terms of external economic indicators requires redefining, to allow for a more positive strategy in development.

(iii) Development should be self-determined and self-generated.

(iv) Development should be approached co-operatively and collectively.

(v) Development should be integrated. This implies that artificial growth of certain sectors and truncated growth of others, often defined by vested interests within a country or through policies from outside, can cause dependency and underdevelopment.

(vi) Development should be planned and it requires constant attention from and intervention by a national authority to ensure that short-term interests do not pre-empt long-term considerations, particularly when influences from outside the country come into play.

(vii) Development needs to be directed towards establishing a just and equitable social order. This implies structural transformations allowing for participation by all sectors of the population.

(viii) Development must be democratic in that it must respond to choices made by the population as a whole. The goals of society have to be largely set by itself, and S&T are to be a means to accomplish these goals. (It is true that scientific developments result in situations that could not have been conceived of by society in setting its goals, and these need to be taken into consideration in an iterative procedure).

(ix) Development must be competitive so that the less developed countries or regions are not left out as special areas leading a marginal life, far from the main flows of growth and dynamism. It is important to encourage active participation in a new optimal division of labour which is at the heart of the objectives of the NIEO.

(x) Development should be innovative in that it must not depend on import of out-moded technology nor upon advanced technology developed elsewhere. Only the mastering of world scientific knowledge, including the knowledge which for economic reasons has never been applied in developed countries, can ensure genuine creative technological development.

(xi) Development planning should be based on a realistic definition of national needs and value systems.

Whilst the above is a particular viewpoint, it would contain a large measure of agreement in developing countries. This has been outlined only to illustrate the philosophy behind the discussions of UNCSTD on the role of S&T in development.

The second point of concern was that, faced with the continuously and rapidly growing mass of information, there is a tendency to utilise modern technology to create numerous large data bases without bothering too much about what information should be recorded and what had better be left out. A great deal of recorded information will never be used and the active life of many data banks will be short. A surfeit of information is even worse than lack of information, as it usually implies waste of energy and waste of money. There was thus the basic question of organising appropriate information systems.

The third problem of concern was the shortcomings in the methods and technologies of information processing such as standards for information handling, compatibility of both software and hardware, etc.

While there was general agreement on the need for appropriate global information systems, operating in the form of a network, involving national information systems which are themselves integrated with the national S & T policies, there was some concern about the costs and feasibility of an all-embracing system, and considerable disagreement between the developing and developed countries on the question of the information content in such a system

Transfer of technology

The Agenda for the Conference had eight items of which the first three were on formal and organisational aspects. Agenda items 4 to 8 were substantive Items 4 and 5 had four and five sub items respectively One of these items, 4(a), was on Choice and Transfer of Technology for Development. This was one of the most important and thorny issues before the conference, on which no agreement could be reached even after very extensive discussions.

The developing countries, for many reasons, had always felt that aspects relating to choice and transfer of technology should be discussed at UNCSTD. Firstly, because UNCSTD was a conference on *science and technology for development* and aspects relating to technology in its various facets of choice, assessment, and transfer should, therefore, figure in the conference. Secondly, in their view the global concern towards the establishment of a New International Economic Order was,in essence, an acknowledgement of the validity of their demand to acquire a more equitable share in the output of the world's industrial goods.

For the developing countries industrialisation is essential for several reasons. First, a shift from primary to secondary sector development would



UNCSTD Secretary-General, Joao F da Costa

give comparative advantages in the production of manufactured consumer goods, and eventually capital goods. Further, industrialisation would provide gainful employment for an expanding population without reducing per capita income, as agriculture often threatens to do. It is to be noted that, by the end of the century, labour forces in the developing countries will increase almost three-fold

During the 1950s and 1960s, the pattern of industrialisation in the developing countries was largely an imitation of the industrial development of the developed countries Unfortunately, such an imitative form of industrialisation failed to bring about the widespread social and economic benefits that are supposed to result from economic growth While there has been some marginal rise in the gross national product (GNP), the growth of employment in modern industry has been low and income distribution has not improved. This situation has been aggravated by an increasing gap between the urban centres, where modern industry is concentrated, and the rural areas.

At present, transfer of technology takes place in a manner which excludes the local scientific community from any involvement in the transfer process or access to relevant information. On the other hand, if the local scientific community were also to be involved in the transfer process, there would be, firstly, no need to import those elements that could be developed and produced indigenously through the national effort (involving therefore the concept of unpackaged technology); and secondly, the know-how which would come from outside would be understood and assimilated in the country in a manner that the local scientific capabilities could then work on it to adapt, modify and improve for further usage.

There was general agreement by all concerned that science is a common heritage of mankind; and that access to scientific information should be freely available to all. However, there was disagreement on the question of whether technology could be considered as a common heritage of mankind, with free access to all. The developed countries argued that technology was like any product which was saleable, and it was entirely a matter of negotiation between the seller and the buyer. They further argued that matters relating to transfer of technology, code of conduct, transnational corporations, etc were under extensive discussion at other forums such as UNCTAD, WIPO, UNIDO, etc. They were, therefore, not prepared to discuss these at UNCSTD. They would not accept the argument that the discussion at UNCSTD was from a completely different angle and perspective The developed countries of the free enterprise system argued that their governments, even with the best of intentions, were powerless to influence the actions of their private corporations with regard to straightforward commercial negotiations.

International financing mechanism

ACAST in its World Plan of Action, had suggested the need for the creation of a World Plan of Action fund or account which would have, as its main function, to act as a catalyst in bringing about the concerted and concentrated attack which the ACAST had felt necessary. Such a fund or account could clearly enable leadership and initiative to be provided in identifying, and partially financing, the high priority projects to which the World Plan of Action draws particular attention.

ACAST had argued that: (i) the developing countries should increase their outlays on research and development and provision of scientific and technical services to one per cent of their GNP by 1980; (ii) developed countries should increase their S & T aid to developing countries to the extent of 0.05 per cent of their GNP (with the GNP of the developed countries in 1970 being of the order of $ 2,500,000 million this would involve an amount of $ 1,250 million); (iii) developed countries should devote 5 per cent of their non-military research and development outlays to the science and technology needs of the developing countries.

No such fund for S & T was ever created. There have, of course, been outlays by the specialised agencies such as UNESCO, WHO, FAO, etc and also by UNDP on certain projects in the field of science and technology. The

need for an international financing mechanism to provide $ 2 billion by 1985 and $ 4 billion by 1990 was one of the major issues brought up by the developing countries before UNCSTD

The arguments put forward by the developing countries were relatively simple and entirely plausible. They claimed that the developing countries themselves would be spending, in their own national efforts relating to S & T, amounts several times larger than the figures indicated by them for the international financing mechanism. What they were asking for, therefore, was not that developed countries should support the whole or the major part of this effort to grow endogenous S & T capabilities in the developing countries. They were only asking for a small percentage of the total. They also pointed out that amounts presently being spent by the developed countries for armanents was of the order of several hundred billion dollars a year; the amounts being asked for by the international financing mechanism was a minute fraction of this. They argued that the amounts asked for are entirely in consonance with the broad commitments already indicated in connection with the Second International Development Decade, and of a magnitude similar to those indicated by the World Plan of Action prepared by ACAST, of which many distinguished scientists from the developed countries were members. The developing countries were of the view that resources of the global financing mechanism should be substantial, and supplementary to the resources that now exist, and furnished on a predictable, automatic, and continuous basis.

The developed countries referred to the inflationary situation of the world economy; the difficulties they faced consequent to the increasing costs of oil; the fact that there had not been time to examine these proposals in detail within the governments of the developed countries prior to UNCSTD, that for such large amounts to be collected and properly distributed one would have to look carefully at the organisational structure and administrative machinery; that their governments and other bodies would have to be convinced on the details and the manner in which such amounts would ultimately be expended; and that they were not agreeable to any "assessed" contribution for such a fund but only to voluntary contributions.

After a great deal of discussion, it was agreed that there was need for increased international financing for science and technology, to support a broad range of activities aimed at strengthening the endogenous scientific and technological capacities of developing countries, in particular to assist in implementing the measures envisaged in the Vienna Programme of Action.



Indian farmer tunes in with transistor radio while protecting his crops. The fruits of technology are trickling in everywhere

Special Working Group on S & T and the future

This working group was specifically set up with the mandate to discuss items on the agenda of the Conference entitled "Science & Technology for Development", "New Science & Technology for overcoming obstacles to development" and "Science & Technology and the future". Many outstanding scientists from different parts of the world participated in the discussions of this group. A text based on the recommendations of this group was adopted by the conference and included in its report; though it did not appear in the Vienna Programme of Action.

The Vienna Programme of Action consisted of 117 paragraphs on which agreement had been reached. Besides, there were 33 paragraphs on which agreement could not be reached. The principal successes related to the new institutional arrangements, the setting up of an Interim Fund for Science and Technology for Development administered by the UNDP for the period 1980-82, and agreement in principle on a long-term international financing mechanism.

Looking back and forward

Apart from the various comments relating to UNCSTD during the preparatory phase, many analyses and viewpoints concerning UNCSTD have appeared over the past year. In retrospect, and in concluding this article, we would like to express certain personal views concerning the conference, having seen a great deal of the preparations, and the conference itself, at close quarters.

It must be recognised that, in the case of a global conference of this magnitude, there are very many different interests, of the developed and the developing countries, of the various UN agencies, of the highly dispersed S & T community, of non-governmental organisations and so on, each with its own expectations from the conference. It would have been impossible for any conference to meet all of these expectations.

One of the complaints made against UNCSTD was that it was very expensive in terms of the total money spent. Accounting for all expenses incurred within the budgets of the UN system, of governments, of various international organisations, of the scientific and technological community, and of non-governmental organisations, figures of expenditure have been given of not less than US $ 50 million. It must be pointed out that any UN conference will, in principle, be expensive, because of the need for documents in all of the official UN languages, of facilities for simultaneous interpretation, etc.

Whilst the preparatory process for UNCSTD covered almost 5 years, a large part of this was taken up on preliminaries. The real discussions which had a bearing on the nature of the draft programme of action, and the final negotiations at UNCSTD, essentially started with the Third Meeting of the Preparatory Committee in January 1979. The Group of 77 got together effectively only in April 1979, just four months before the conference.

It is very clear that every one of these global UN conferences will have in them elements of the north-south dialogue. The south, represented by the Group of 77, needs to prepare itself adequately for these negotiations. That this was possible only a few months before the main conference was one of the reasons why more could not be achieved in Vienna. The existence of various groups of nations, of which the largest is G-77, is recognised in the UN; and meeting rooms and other facilities are provided for meetings of the groups and indeed of their sub-groups; but this is so only during formally scheduled meetings of committees etc and during conferences. Facilities

do not exist for the largest group, namely G-77 (or for that matter other groups except what they provide on their own) to enter into detailed discussions amongst its members to arrive at a consolidated viewpoint aside from what is possible at formal meetings. A large part of the time at the formally scheduled preparatory meetings and in the main conference is then taken up for this process of reaching a consolidated view. As a result, the time available for real negotiations between groups is greatly restricted, and the preparatory meetings and the conference achieve much less. Indeed the success of UNCSTD can be attributed to the ability of G-77, even a few months before the conference, to consolidate its views on a wide range of issues and immediately before Vienna, at Bucharest, to have these endorsed at a ministerial-level meeting. In the absence of such a consolidated position for purposes of negotiations, all the meetings (whether of the preparatory committees or at the conference at the UN), tend to be only statements and views of individual countries of no consequence to the final outcome

There is no doubt that S&T are moving and changing very rapidly It is important, therefore, for the UN and all its member-states, to take full cognisance of these changes A discussion on this at UNCSTD would have been of great value Again, many felt that UNCSTD should at least have come with an analysis and suggestions for programmes relating to certain sectors and specific problems that are clearly of major global interest These could have been discussed at UNCSTD in view of their great significance for a large part of the world, and since major UN agencies (in some cases more than one) would be involved in the implementation programmes

There are some who have argued that UNCSTD should have devoted significant attention to the possibility of diversion of expenditure on arms to development. Whilst this is a very important issue, it is doubtful if UNCSTD could have achieved much; however, mention concerning this possibility was made both in the meetings of the Preparatory Committee and at UNCSTD There are others who have felt that UNCSTD should have discussed alternative strategies for development. But UNCSTD was really not equipped for discussing the political, economic and sociological aspects involved in this. And indeed, concerning this topic, and that relating to disarmament, there are major forums at the UN.

Immediately prior to UNCSTD was held the UNCTAD meeting in Manila. Soon after UNCSTD was held the UNIDO III meeting in New Delhi. When one sees the controversies and lack of progress at these two meetings that preceded and followed UNCSTD, one can see the magnitude of the difficulties involved in the north-south dialogue.

In comparison one did achieve, at Vienna, a remarkable degree of non-controversial discussion and an effort to understand one another. As a result, a certain degree of success was achieved, with the possibility that the issues that remained unresolved could be discussed further under the auspices of the newly set-up IGCSTD

UNCSTD was clearly a part of a major activity that is in progress to bring into the United Nations the dimensions of science and technology, in addition to what the UN has always been accustomed to discussing: political, social and economic issues. UNCSTD and the preparatory phase for it certainly succeeded in sensitising countries, agencies and a large S&T community in the world concerning the various issues involved

The disparities which exist between the north and south are not only in the area of science and technology but in the totality of the socio-economic sphere An independent Commission on International Development Issue, set up under the chairmanship of former Chancellor of the Federal Republic of Germany, Mr Willy Brandt, recently completed its deliberations and has come out with a report entitled "North-South A Programme for Survival" In its recommendations it has considered the problems of the poorest countries, where issues of hunger, food and population are very important. The commission has recommended an action programme which would require additional financial assistance of at least 4 billion dollars a year for the next two decades While examining each of their recommendations carefully, one can identify the role that S&T can play in these, and the importance of strengthening endogenous capabilities for this The need for improvement in existing arrangements pertaining to principles and codes connected with technology transfer have also been emphasised. Recommendations have been made concerning the development of appropriate technology in the light of the changing constraints relating to energy and ecology; and that the flow of information about such technologies should be improved. It has been recommended that the international aid agencies change their practices, which restrict the recipient's freedom to choose technology, and it is suggested that more use of local capacity be made while preparing the projects.

It is clear that the programme of action evolved at Vienna, as well as the programme of survival outlined by the Brandt Commission, have rightly emphasised the role of S&T, and the responsibilities which have to be undertaken by the north as well as the south.

Mankind is at a turning point and many conceptual and structural changes will need to be made as we move into the future.

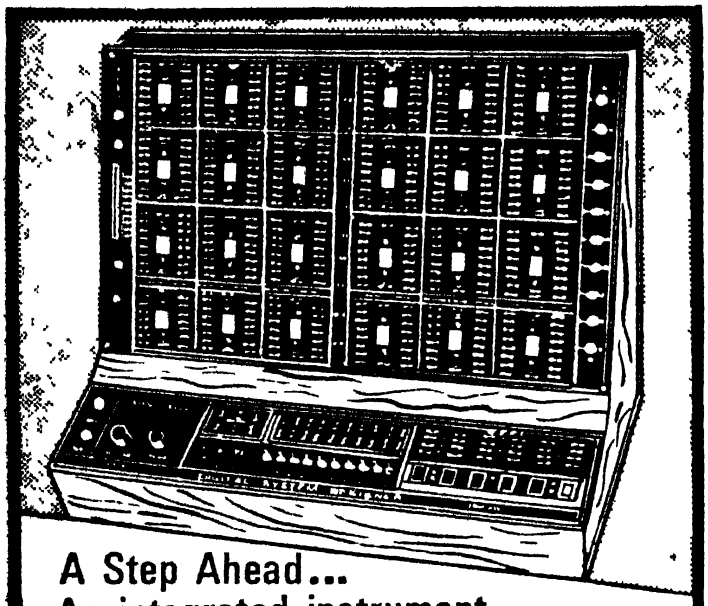


Menon and Lavakare

Dr M G K Menon FRS, is Secretary to the Government of India Department of Science and Technology He was a member of the UN-ACAST for seven years (1972-79) and its Chairman for two years Dr Menon was also Chairman of the UNCSTD Preparatory Committee at its third, fourth and fifth sessions, alternate leader of the Indian delegation to the UNCSTD and Chairman, Second Committee, UNCSTD

Dr P J Lavakare is at present Project Coordinator with the Department of Science and Technology He was Member-Secretary of the Indian delegation to the UNCSTD

Recommend reading **1.** *World Plan of Action for the Application of Science and Technology to Development*, UN Publication Sales E 71, II A, 18, New York (1971); **2.** *Pugwash on Self-Reliance* Ed W K Chagula, B T Feld A Parthasarthi and P.J, Lavakare Ankur Publishing, New Delhi 16 (1977) **3.** *Scientific Co-operation for Development—Search for New Directions*, Ed P J Lavakare Ashok Parthasarthi and B M Udgaonkar, Vikas, New Delhi (1980), **4.** *Science, Technology and Society—Needs, Challenges and Limitation* Ed Klauss-Heinrich Standke and M Anandakrishnan, Pergamon Press (1980), **5.** *What Now—Another Development*, The 1975 Dag Hammarskjold Report—Development Dialogue No 1/2 (1975) **6.** *North-South, A Programme for Survival* Report of the Independent Commission on International Development Issues under the Chairmanship of Willy Brandt M I T Press, Cambridge, Mass U S A (1980)



A Step Ahead...
An integrated instrument for integrated circuits...
AEC DIGITAL SYSTEM DESIGNERS

MODEL DSD-3

Versatile and self-contained laboratory demonstrator Plus a digital system development instrument to conduct simple and advanced experiments in combinational and sequential logic circuits. Using III and IV generation ICs. for training and simulating industrial designs

ADVANCED AND EFFORTLESS

For quicker, neat and efficient breadboarding of digital logic gates to develop, build and test complex systems before constructing prototypes.

Using 24 numbers of 16-pin dual in-line IC sockets and a 22-pin edge-connector for solderless interconnections and disconnections
Also can be used as Dynamic Digital Integrated Circuit tester under actual operating conditions

COMPLETELY SELF-CONTAINED

* Contains everything needed to assemble, test the logic circuits
* Built-in input signals and output indicators, such as power supplies, clock signals, pulsers, logic status indicating lights, logic switches and digital displays
* Eliminates cumbersome and maze of component boxes, separate power supplies, pulse generators etc.

A MUST FOR EVERY ADVANCED ELECTRONICS LABORATORY ENGAGED IN TRAINING AND DEVELOPMENT OF DIGITAL CIRCUITS.

MODEL DSD-4

Similar to DSD-3 except that it has
* 16 Nos. of 16-pin Dip Sockets
* 4 Nos. of 24-pin MSI/DIP Sockets

For further particulars, please contact

ALLIED ELECTRONICS MFG. CO.
337, Thambu Chetty Street, Post Box No. 203
MADRAS-600 001 Phone 422269/445904/423368

SUBRA & RAM A 2

camel ink

In six inspiring shades for smoother flow and beautiful clean writing.



S 801

Chokeless welding transformer

A TRANSFORMER is expected to be smaller in size and weight than an induction motor of the same rating or capacity, and generally it is. A welding transformer, however, is much bigger than a corresponding induction motor. It costs more than an ordinary transformer, because some sort of a separate choke becomes necessary for a welding transformer. I shall discuss below an alternative arrangement which will be cheaper and simpler.

A choke becomes necessary because of the negative characteristics of an arc. Its resistance decreases as current increases This may become an unstable situation and the arc may either die out or exceed the needed intensity even with small fluctuations in current A choke is nothing but a reactance with high impedance. It is connected in series with the load. Its high impedance offsets the effect of the negative characteristics of the arc and stabilises the arc and the current

There are two types of welding transformers currently available in the market The first is the stepped controlled three-phase welding transformer shown at Fig 1 The primary of the transformer is connected in an open delta and a separate choke in series with the load is connected to the secondary as shown in the figure

The second type available is the stepless controlled three-phase welding transformer shown at Fig. 2 Two phase-lines are connected to a centre tap auto-transformer The third phase and the centre tap are connected to the step-down transformer which is provided with a movable core.

The alternative arrangement is shown at Fig. 3. In this simple arrangement we insert a coil, which I call the Bhama coil, in the central limb of the core, connected as shown in the figure. This simple arrangement allows us to control the arc current effectively.

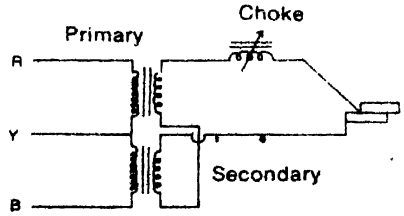


Fig 1

Besides the two primary coils *a* and *b*, the Bhama coil *c* is a coil with taps which can be connected to the supply through multiway rotary switches to get the required current range. Only *a* and *b* have secondary windings on them.

With a choke, when the load is connected to the secondary and the current increases, it causes the choke to absorb a larger part of the voltage and the voltage across the load decreases. This offsets the negative characteristics of the arc. The reverse takes place when the current decreases. The same effect is achieved in the alternative arrangement. When the load is connected and the current increases, the voltage across the Bhama coil can be increased and the voltage across *a* and *b* decreases. The reverse takes place if the current decreases. The range of variation of the secondary voltage depends on the ratio of the number of turns of the Bhama coil to the turns on coil *a* and coil *b*.

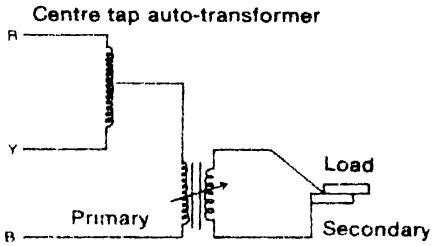


Fig 2

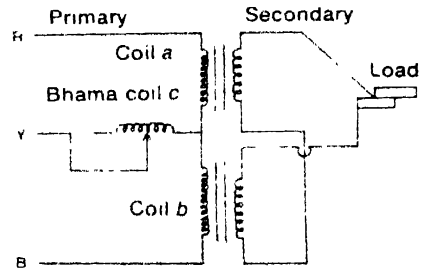


Fig 3

The net effect is a fall in voltage as the current increases and vice versa, which is the same corrective action as the choke. This is made possible by the Bhama coil inserted on the primary side.

This alternative arrangement has a number of advantages. The wires and stampings required for the choke will be saved. There will also be a resultant saving in the quantity of oil, roughly 25 per cent. Further, the current control is on the primary side. Primary currents are low so that the arrangement requires less maintenance. The elimination of the choke, which is nothing but a reactance, will also be expected to improve the power factor. Finally, the arrangement is simple and that, perhaps, is as important as any of the other advantages.

S. J. KULKARNI

Mr. Kulkarni is an electrical engineer and a private consultant and transformer manufacturer at Kagal in the Kolhapur district of Maharashtra.

Sonochemistry—a new discipline?

ANY reacting system needs to be supplied with energy. The most common, and the oldest method of doing this is heating which dates as far back as the time of the alchemists, when chemistry was yet to become a science. Modern chemistry has found new ways of supplying reacting systems with energy. One of them involves the absorption of electromagnetic radiation on irradiation with ultraviolet or visible radiation. Reactions that proceed in this manner are known as photochemical processes and their study has become a legitimate part of chemistry—photochemistry.

Can reaction systems use sound waves usefully? Apparently, they can. Recently S. Moon, L. Duchin and J. V. Cooney have reported an interesting application of ultrasound to organic reactions (*Tetrahedron letters*, **3917**, 1979). It was found to facilitate the two-phase basic hydrolysis of aromatic carboxylic esters The reaction systems were irradiated with ultrasound of frequency 20,000 Hz by an ultrasonic probe immersed in the reaction mixture. The conventional method of two-phase ester-saponification involves refluxing the reaction mixture. The period of refluxing the mixture was generally 90 minutes.

With methyl benzoate, saponification gave a 97 per cent yield of benzoic acid in 90 minutes of refluxing. The same hydrolysis took only 10 minutes with the application of ultrasound. In the saponification of methyl 3,-5-dimethyl benzoate, the yield obtained by 90 minutes of reflux was quite comparable to that obtained by 10 minutes of irradiation with ultrasound.

The saponification of methyl 2, 4-dimethyl benzoate proceeded to the same extent of 15 per cent for both, the conventional 90 minutes of reflux and 10 minutes of ultrasound irradiation. However, when saponification with ultrasound was continued for 60 minutes, the reaction yield dramatically jumped to 94 per cent. Yet, attempts to saponify methyl 2, 4, 6-trimethylbenzoate by 90 minutes of reflux and 10 minutes of ultrasound irradiation failed.

One thing, however, is definitely established. Ultrasound has catalysed two-phase esterification to the extent that reactions requiring 90 minutes of reflux have been achieved with only 10 minutes of ultrasound irradiation. This clearly speaks of the possibility of industrial applications as well. It would not be surprising to find that ultrasound is likely to catalyse several reactions and a new area of chemistry, sonochemistry, may spring up shortly.

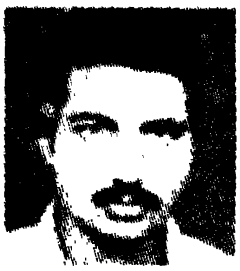
C. SRINIVASAN

Dr. Srinivasan teaches chemistry at Madurai Kamaraj University, Tamil Nadu.

MEDICAL ENTRANCE



Sunil Kumar Bansal
1st in Medical Entrance Delhi '77



Raghavendra Goswami
1st in Medical Entrance Wardha '77



Bhupinder Bhandari
1st in Medical Entrance Delhi '78



Rajiv Verma
2nd in Medical Entrance Delhi '78

THESE TOPPERS WERE OUR STUDENTS

And to crown it, while In 1977 out of the 35 students selected by the prestigious ALL INDIA INSTITUTE OF MEDICAL SCIENCES, as many as 16 were our students, in 1978 out of the 25 students selected by the same A.I.I.M.S., as many as 11 happen to be our students.

NEED WE SAY ANYTHING MORE ABOUT OUR RESULTS?

You too, have an opportunity to secure a position in these tests.

RESULTS OF I. I. T. ENTRANCE EQUALLY BRILLIANT

ENSURE YOUR SUCCESS THROUGH OUR COMPREHENSIVE

CORRESPONDENCE COURSE

ALSO PERSONAL TUITION CLASSES FOR I.I.T. AND MEDICAL ENTRANCE
HOSTEL FACILITIES EXIST

SACHDEVA NEW P. T. COLLEGE

29-T PATEL NAGAR, NEW DELHI-110008
32-T NEHRU PLACE, NEW DELHI-110019

The problem of trans-boundary pollution

Armin Rosencranz

International environmental law is likely to be of increasing importance as our understanding of transport of air pollution improves

IN THE CONTEXT of Europe's more than 30 countries, the long-range transport of air pollutants is obviously an international concern. Using 1973 data for West European countries, the Air Management Group of the Organisation for Economic Cooperation and Development (OECD) has calculated that 63 per cent of all sulphur emissions represent national depositions, 17 per cent reciprocal depositions, and 20 per cent one-way depositions. Although these figures indicate that sulphur control is predominantly of national concern, they also suggest that sulphur emissions have transnational significance, especially for the "net importing" countries. Very conservative damage estimates show that, in OECD Europe, control costs would more than be paid back in benefits to crops, fish, materials, and human health. More research may also be necessary to determine appropriate control steps for abating transnational sulphur pollution. In addition, greater knowledge of actual damage is necessary to determine either the optimal or minimal level of pollution.

National control strategies

The easiest and most widely used control strategy is dispersion: tall stacks attached to power plants ensure against the sulphur dioxide (SO_2) falling in the neighbourhood of the power plant. Instead, the tall stacks disperse the SO_2 high enough in the atmosphere to enable it to travel long distances and — ironically — to come down eventually over a wider area.

Other common and relatively inexpensive strategies include using oil and coal low in sulphur content and the siting of power plants in remote areas. Another possible strategy is reliance on (sulphur-free) nuclear power, which may not take place. Mass-market solar power, also sulphur-free, is unlikely to be developed in time.

The escalating price and uncertain supply of oil and natural gas have caused industrial countries to fall back increasingly on coal to fire their electrical power plants. Unfortunately, most coal is higher in sulphur content than is oil or gas.

The US, Norway and Sweden, which with Canada are the countries most harmed by acid rain, have looked to improved technology to curb SO_2 emissions. Such technologies include flue-gas desulphurisation, fluidised bed combustion, coal gasification, and coal liquefaction. Currently, all of these technologies are costly, energy-intensive, and pose waste disposal problems.

Some international responses

Most industrial countries view pollution control technology as too costly right now, and economic and energy supply considerations seem too overwhelming for one realistically to expect large-scale reduction of acid deposition and its sulphur precursors. With the possible exception of the US and Japan, industrial countries are willing neither to invest the capital nor to strengthen their existing air pollution control policies to ameliorate the problem of long-range transboundary air pollution.

It is clear that acid deposition is an international problem. While a relatively undeveloped field, international environmental law is likely to be of increasing importance as scientific understanding of the long-range transport of air pollution improves and the extraterritorial consequences of domestic pollution control decisions become more evident. (As used here, *international environmental law* refers not only to legally binding treaties and decisions by international tribunals but also to the declarations of international organisations which reflect customary rules of conduct among nations.) International legal principles and practices may offer guidance concerning all nations' responsibilities to ameliorate the problem. Probably the most influential of international statements on this subject is the 1972 Declaration of the United Nations Conference on the Human Environment in Stockholm, which provides in Principle 21 that:

States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.

Principle 22 provides that:

States shall cooperate to develop further the international law regarding liability and compensation for the victims of pollution and other environmental damage caused by activities within the jurisdiction or control of such States to areas beyond their jurisdiction.

Analogous principles may be found in the more developed area of international water pollution. The Helsinki Rules, promulgated at the 1966 Conference of the International Law Association in Finland, are regarded as a comprehensive expression of the international law of rivers. The Helsinki Rules adhere to the proposition that states do not have the right to pollute so as to cause "substantial injury" to another state and provide for abatement of the offending pollution and compensation for extraterritorial damages.

The ECE convention

In the fall of 1979, members of the Economic Commission for Europe (ECE), an United Nations Organisation with 34 member states including Canada and the United States as well as eastern and western European countries, signed a "Convention on Transboundary Air Pollution." It is the first international accord to address this problem. The significance of the ECE Convention lies largely in its recognition of the international nature of the long-range air pollution transport problem. The agreement establishes avenues of international co-operation in monitoring and research activities and in the joint development of air pollution control strategies but does not compel

The plume from a metal smelter at Sudbury, Ontario, Canada, stretches for at least 80 km



abatement action. It includes no mechanism for enforcement of its terms, nor does it delineate the responsibility of member states to abate pollution-causing damage in another state or to award compensation for such damage

Each Nordic country made a plea that necessary resources be made available for the ECE Secretariat to implement the Convention Canada urged ECE members not to resort to a least common denominator' programme, and Sweden and Norway called for technological controls to be installed internationally to reduce sulphur emissions For the most part, countries that chose to mention their domestic strategies for sulphur control had existing or planned programmes that included technological control measures

The limits of the law

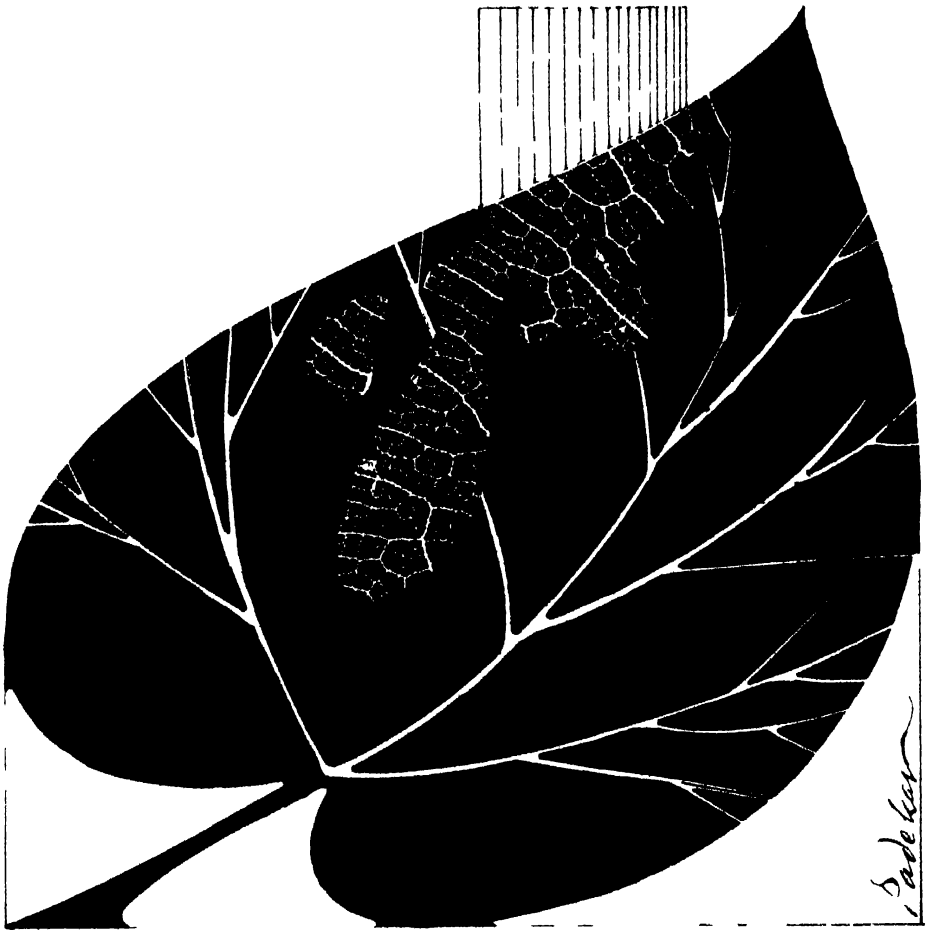
The present international legal framework does not effectively foster preventive action, although several international organisations clearly subscribe to the notion that prevention is the best means of avoiding environmental harm While general principles concern the responsibilities of nations to provide compensation for the damages caused by transboundary pollution, they are of only limited utility in avoiding permanent environmental damage

For several reasons, accepted notions of international law cannot alone compel major modifications in the pollution control policies of industrialised nations General statements concerning the duty of states to avoid actions adversely affecting the environment of other nations do not indicate precisely what types of conduct are unacceptable A certain amount of pollution invariably accompanies industrialisation, and there is no international right to a pollution-free environment International legal principles do not yet describe the point at which a nation's interest in industrial development must yield to concerns surrounding the effects of transfrontier pollution

Moreover, there is no mechanism yet for enforcement of any international legal doctrines

In the few existing applications of international environmental law where the nations involved have consented to be bound by the decision of a neutral tribunal, claimants have been required to demonstrate that specific identifiable sources have caused environmental injury Unfortunately, because of the incomplete scientific understanding of both the atmospheric chemistry and effects of acid sulphates and nitrates, it is difficult to assign to individual sources the responsibility for acidity in distant areas. Yet if action were to await a clear link between emissions and distant environmental effects, irreversible damage would almost certainly take place in acid-sensitive areas

Past international environmental controversies have, in general, focused on individual pollution sources or sources contributing to pollution in a clearly defined watershed To address acid deposition, it will be necessary to broaden the international focus to consider each nation's contribution to the total regional atmospheric pollution load Incorporating international considerations on such a fundamental level in moulding national pollution control strategies would be a significant step forward



A bilateral response

As the governments of the United States and Canada have come to appreciate the gravity of the transboundary air pollution problem, cooperative activity in the area has increased Informal discussions on transboundary air pollution between the Canadian Department of External Affairs and the US State Department were initiated in December 1978 Formal negotiations are expected to begin shortly

Efforts to forge an effective accord, one that will significantly reduce the transboundary flow of acid-forming air pollution, are complicated by a number of considerations like the natural unwillingness of both nations to yield some degree of national sovereignty over domestic pollution control decisions, developing an abatement agreement compatible with the different approaches of the two countries, developing a concrete abatement programme in the face of the scientific uncertainty surrounding many aspects of the acid deposition problem, etc

The "Polluter pays" principle

Compensation of injured parties serves not only to provide monetary or other relief to persons suffering damages but also to require the polluter to bear the costs of its pollution Pollution victims could be compensated by applying to the judicial and administrative tribunals of the polluting country or by setting up environmental damage funds or other insurance systems but the multiplicity of sources and their relative contribution to atmospheric loadings make it difficult to prove a claim and to assign liability Remedies are further complicated by questions of jurisdiction, namely, whether the

offence is committed at the emission source or at the point of damage

When the individual polluter cannot be identified or when formidable obstacles to recovery exist, an environmental damage fund is another way to provide compensation A claimant would be entitled to compensation by demonstrating environmentally related damages to an administrative agency the amount of compensation would be subject to clear criteria and guidelines In the case of sulphur pollution funding for such a system could be obtained from a surcharge on the sulphur content in fuels or could be based on source receptor linkage studies indicating the amount of acid sulphates that a country deposits on other countries

Determining acceptable levels

To undertake collective action to resolve problems associated with the long range transport of air pollutants requires that countries agree on maximum acceptable levels of transboundary flow of air pollutants The instruments adopted to achieve desired levels need not be regulatory economics based approaches may prove effective To a large extent however the unknowns of the acid precipitation phenomenon hamper all approaches

Optimum ceilings for total atmospheric loading need to be established if the transboundary flow of sulphur pollution is to be reduced Methods must then be found to achieve significant emissions reduction at acceptable costs Underpinning both the optimum ceiling and the acceptability of costs is an accurate determination of how much damage could be avoided through various degrees of abatement Without accurate dose-response damage functions determining the cost effectiveness of various methods is conjectural

Analysis performed by OECD indicates that on a West European basis uniform percentage reductions through joint actions promise significantly greater benefits for both importers and exporters than individual action Equitable bases for computing such reductions among countries include emissions as a ratio to population to gross national product, or to energy consumption The allocation formula would have to be adjusted to account for emissions abatement steps already undertaken in particular countries, if such steps varied significantly taken from those in other countries

Establishing a ceiling on national emissions would give each country latitude in adopting the mix of control steps best suited to the country The



Lime being sprayed from helicopter on New York State lakes to neutralise the acid

economic costs for a particular country could vary widely depending among other things on the availability of low sulphur fuels clean energy sources and supplies and industrial make up If such ceilings represented mandatory requirements however some internationally agreed upon mechanism for monitoring and enforcement would be necessary

Prospects and prognosis

Although numerous control strategies policies and technologies are available the pressures today are in the opposite direction— to relax air quality and emissions standards to make coal generated electric power more efficient and economical

Within the context of the US-Canada acid rain negotiations it is in the interest of both nations to abate the flow of acid rain across their common border As a first measure both countries may agree to install scrubbers on those sources near the border that emit the most sulphur oxide (SO_x) pollution Coal fired power plants bordering the Great Lakes could be exemplary targets

The United States Environmental Protection Agency is already unilaterally considering the modest additional control policy of mandatory coal washing to reduce the flow of acid rain to Canada However neither country seems likely to overhaul its existing sulphur control policies Most important there is no reason to suppose that existing (that is pre 1970) sources – which account for most of the sulphur pollution problem in the United States – will be subjected to technological controls in the foreseeable future

The prospects for timely action in Europe look bleak Sweden and Norway will undoubtedly call on the ECE signatories to implement the principles of the Convention The polluting countries will probably continue to call for proof of damage, identification of specific sources, and resolution of scientific uncertainties They may propose to bear the modest costs of liming acidified lakes—an offer which the recipient countries will undoubtedly reject as an inadequate substitute for abatement and as potentially dangerous to aquatic ecosystems

The ECE Convention signatories have committed their countries to adopt the best available technology economically feasible Economic feasibility is, of course the critical caveat Environmentally progressive countries, such as the Netherlands, West Germany and Sweden have already equipped some sources with desulphurising technologies More backward countries, by contrast, seem to regard even a modest reduction in sulphur content of fuels as draconian

The most likely area for progress may come through implementing the Convention's provisions for exchanging available information on major changes in national policies and in general industrial development and their potential impact which would be likely to cause significant changes in long-range transboundary pollution Aggressive implementation by victim countries of this provision and of its attendant notice and consultation requirements would afford an opportunity to attract media and citizen attention in the polluting countries, which could not help but have a salutary influence on the polluters' plans for sulphur control

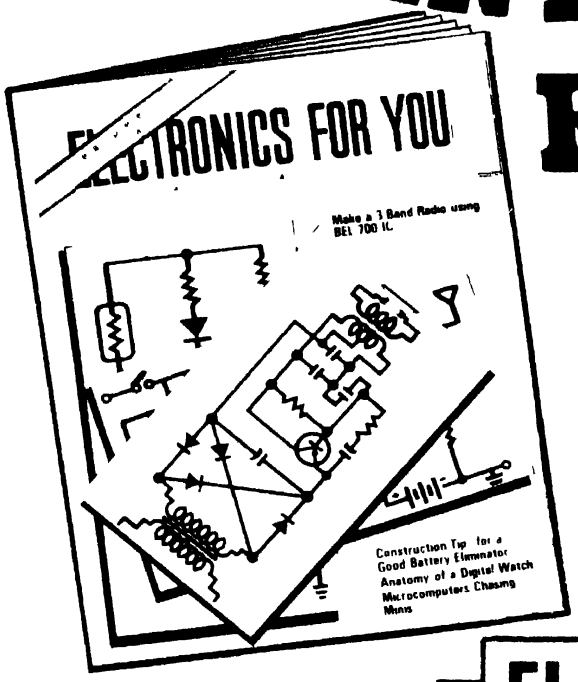
The publication by the ECE Secretariat of member states energy scenarios could offer another wedge for victim countries to influence the policies of the polluting countries The major trading partners of those countries furthest behind in sulphur control would be likely also to add their weight to these discussions to ensure that industries of the lagging countries gain no competitive advantage over counterpart industries in environmentally progressive countries

Broad multilateral subscription to coal utilisation technologies may yield economies of scale sufficient to make them affordable

Finally, ECE-mandated multilateral research on crop damage and health effects from sulphate aerosols and acid rain may sooner or later demonstrate clearly the cost-effectiveness– indeed, the necessity—of controlling and abating sulphur emissions throughout the industrial world That ultimately, would mobilise the citizenry and would induce responsible officials to revise upward their estimates of what is economically feasible

This is an abridged version of the article that appeared in *Environment* June 1980

INTERESTED IN ELECTRONICS



YES !

Then You'll be interested in

ELECTRONICS FOR YOU

India's most popular magazine on the subject.

It's popular because it gives what you want For example construction projects circuit ideas and lots of information of practical nature

You'll like it whether you are an entrepreneur, businessman, engineer technician student, hobbyist, or a lecturer in electronics

Chances are, you are already reading the magazine regularly If not, don't waste any more time The magazine's back issues are difficult to get So, order your subscription today Or pick up your copies regularly from a prominent news stand in your town

In case you have any difficulty in obtaining the copies, please do let us know

Subscription Order :

Circulation Incharge
ELECTRONICS FOR YOU
303 Dohil Chambers 46 Nehru Place
New Delhi 110019

Please enrol me as a subscriber to ELECTRONICS FOR YOU for a year

NAME _____
(In block letters)
ADDRESS _____

_____

I am sending a sum of Rs 35 - in cash by demand draft/money order crossed cheque* Indian postal order in favour of EFY Enterprises Pvt Ltd Please send me receipt for the same

Signature

* Add Rs. 2 00 please on an outside Delhi cheque.

Two books on electronics

Industrial Electronics by Noel Morris Tata-McGraw Hill 1979 305 pp Rs 22 50

THE USE of electronics has now pervaded almost every area of life and is therefore of interest to many people in gaining some appreciation of its applications in their own fields. Its early applications such as in radio and TV are classified as entertainment electronics. The scope of electronics has widened in the past three decades and it now has applications in various industries which constitute a separate branch known as industrial electronics. The major applications are in instrumentation (measurement of non electrical parameters (such as temperature, pressure and pH) control of processes as per a predetermined schedule which may be programmable and generating and controlling the motive power for driving machines. These require a different emphasis in the treatment of the subject of electronics.

On account of these developments electronics is now taught for all branches of engineering. The aim is to make students familiar with the basic principles and some typical applications. These courses are also taught to some of the science colleges. They have however met with limited success so far for two reasons. Firstly the application of electronics in industry call for a different emphasis unlike what is common in entertainment electronics and there are few instructors who teach the subject with this emphasis. Secondly suitable books are not available. Therefore the appearance of a book with a specific title Industrial Electronics attracts immediate attention and raises expectations.

Morris's book has many commendable features. It is compact and priced reasonably. The quality of printing is good and diagrams are neatly drawn.

The chapter headings make an impressive reading containing almost every topic one would like to cover in a basic course on industrial electronics. It is the relative emphasis on different topics which is rather disappointing. For example in industrial electronics practice there is less importance for AC amplifiers than for DC amplifiers, but the book, by giving a very thorough treatment to the former and only a cursory treatment to the latter has unfortunately reversed the emphasis. Similarly the subject of thyristors is dealt with in five pages only and that too without circuit diagrams. This being one of the most important applications of electronics, ought to have been dealt with in greater detail. Another disappointing factor is the treatment of digital electronics which is overtaking analog techniques in many applications. Again while the concepts of logic gates have been explained reasonably well their relevance is not brought out at all.

Some seemingly inadvertent errors have crept in. The velocity of electromagnetic waves in vacuum is stated to be 3×10^8 metres per sec which is correct but it is *not* ⅓ m/μs (1 ft/μs) as stated in the subsequent clause of the sentence (p 39).

Protection of the gate oxide of MOSFETs as mentioned on p 66 was a problem a few years ago but now internal protection is available by connection of two back to back diodes between the gate and the source.

The nomenclature of different types of distortions in amplifiers given on pp 151-3 is not standard. The non linear or harmonic distortion is generally called amplitude distortion whereas the amplitude frequency distortion is called frequency distortion. The book describes frequency distortion as amplitude distortion, which is surprising.

The brief chapter on Noise in Electronic Circuits contains some serious and fundamental mistakes. Fig 12.1 on p 184 which shows noise power vs frequency must be labelled as noise figure vs frequency. The noise power cannot increase with frequency continuously without limit as shown in the figure because this on integration gives infinite total power which is impossible. The statement on p 185 that one source of this (1/f) noise is ripple (or flicker) from rectifiers is wrong. Ripple is different from noise and it can be totally avoided if we use a battery supply. If the contribution of ripple were to be included it will give discrete lines superimposed on the 1/f spectrum with a spacing of the fundamental ripple frequency.

P J JOGLEKAR

Dr Joglekar is an electronics consultant in Bombay

Operational amplifiers

An Introduction to Operational Amplifiers by S V Subrahmanyam Macmillan 1980 128 pp Rs 12

ELECTRONICS hobbyist engineering students or those who want to know about fundaments and applications of integrated circuit operational amplifiers will find this book useful.

Beginning with schematic equivalent circuit details of 741 and 3900 type of integrated circuit operational amplifiers the book deals with basic applications such as inverting and non inverting amplifiers differential amplifiers and current and voltage followers. It also explains offset voltages currents the drift common mode rejection open and closed loop gain frequency response stability slew rate and other terminology associated with the specifications of operational amplifiers along with experimental evaluation of some of these characteristics.

The later chapters of the book deal with fundamental applications such as mathematical operators waveform generators and active filters. The chapter on mathematical operation explains basic circuits for analog addition subtraction, averaging integration and differentiation. The waveform generator section deals with three types of multivibrators Wein bridge oscillator and function generator.

At the end of most chapters there are questions and problems dealing with the concerned area. Inclusion of their solutions would have proved more beneficial.

ANIL V BORKAR

Mr Borkar is an electronics expert and a regular contributor to SCIENCE TODAY

Science Today
October 1980

THE HIGHLIGHTS

Wanted: A systems approach to Science & Technology Plan

Colour TV is no more a technology leap

If zero had not been invented

Can bats help the blind?

Genetic engineering: the new vistas



There's a moment in your life for UCOBANK

She simply fills your days with happiness. Soon you'll want to present her the happiest day in her life.



Give us that moment and we'll give your daughter the marriage of your dreams

Come to us with what you can put aside and we'll show you how you can give your daughter the marriage of your dreams

UCOBANK has many schemes that will help multiply your savings

We'll show you the profitable combinations of these schemes to make your savings grow quicker

By earning more

Visit any of our branches

Happiness for your daughter on her wedding day begins with the moment you decide to make her such a present.

Bring that moment to UCOBANK

United Commercial Bank

the friendly bank round the corner

UCO CAS-62/80

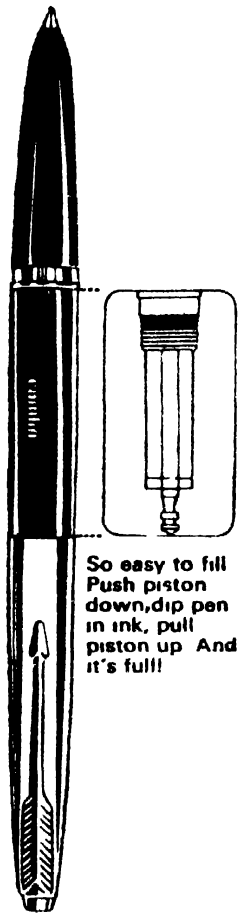
new

UNMATCHED

camlin

PISTON PENS

No time wasted No messing up with ink Camlin Piston Pen mechanisms make it just easy Fill up and feel the difference

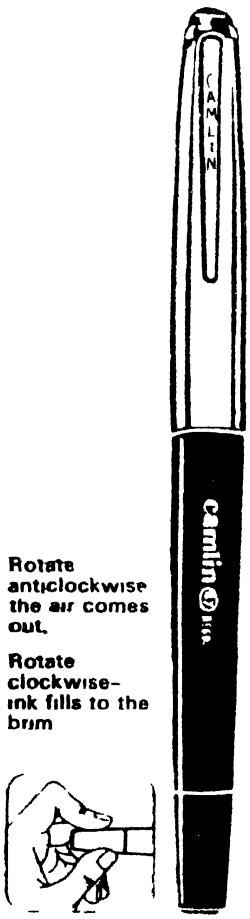


So easy to fill Push piston down,dip pen in ink, pull piston up And it's full!

INJECTION PISTON PEN 48

Rotate anticlockwise the air comes out.

Rotate clockwise- ink fills to the brim



PISTON FILLING PEN 47

S 783

Post-graduate engineering education in India

The Nayudamma Review Committee recommends the setting up of a national authority to administer and evaluate post-graduate engineering education and research

THE Review Committee on Post-Graduate Education and Research in Engineering and Technology set up in 1978, and headed by Prof Y Nayudamma, has found the state of affairs of post-graduate education and research in the country unsatisfactory This, the committee says in its report submitted recently, is mainly because of the "shortcomings in the implementation" of the recommendations made by the earlier review committees The committee has also found the science and technology content in the Indian society and the amount of research and development work very low

The number of scientific and technical personnel per thousand of population is only 3 8 compared to 12 in the US, 19 in West Germany 82 in the USSR and 185 in Japan Similarly the number of scientists and engineers engaged in research and development in India per thousand population is only 0 09, compared to 2 68 in the US 2 97 in West Germany, 3 72 in the USSR and 4 98 in Poland

Of the 74 institutions for post graduate studies in engineering and technology, the performance of about 50 institutions is poor though some of them have developed certain disciplines well A few institutions have, however, done quite well, mainly because of deliberate efforts and liberal investments in promoting them and about 20 institutions have done considerably well, despite lower inputs Post-graduate education and research is a matter of national concern, says the report It should, therefore, get continuous and serious attention

In the committee's view, the capacity for generating and sustaining technological growth within the country has to be strengthened considerably Since the total stock of India's science and technology manpower is quite small in relation to its population and corresponding social needs, this stock will have to grow at a faster rate, particularly in quality in the coming decades The committee, therefore, recommends a much higher national investment in scientific and technical education and research to meet the growing needs of the changing social system

The committee was appointed in June 1978 on a suggestion made by the Expenditure Finance Committee of the Union Government and on the recommendation of the Board of Post-graduate Engineering Studies and Research of the All India Council for Technical Education (AICTE)

The committee consisted of representatives from public and private sector industries, research and development organisations, the UGC the Federation of the Indian Chambers of Commerce and Industry, Institution of Engineers, government departments and educational institutions The members were Prof Y Nayudamma (chairman) former Director-General of the Council of Scientific and Industrial Research, and now a distinguished scientist at the Central Leather Research Institute Madras, Prof C S Jha, Educational Adviser (T) Union Ministry of Education and Culture, Prof B Ramachandra Rao, vice-chairman, UGC Prof M M Sharma, Department of Chemical Technology, University of Bombay, Mr Kan D Mariwalla National Industrial Development Corporation L d, New Delhi, Dr S Varadarajan, Indian Petro-Chemicals Corporation Ltd, Mr F C Kohli Tata Consultancy Services Bombay, Shri J H Doshi, Amar Dye-Chem Ltd, Bombay, Prof Jagdish Narian, vice-chancellor, University of Roorkee Prof A K De, director, IIT Bombay, Prof Shankar Lal, director IIT Kharagpur, Dr V S Arunachalam, director, Defence Metallurgical Research Laboratory, Hyderabad, Prof T R Anantharaman, Department of Metallurgical Engineering, Institute of Technology Banaras Hindu University, Prof G S Ladha, director, A C College of Technology, Madras, Mr J A Kalvanakrishnan, Financial Adviser Union Ministry of Education and Culture, Mr B S Sinha, Joint Secretary, Department of Power, Union Ministry of Energy,

Institutions	Total number	Intake capacity	Actual intake	Out-turn	Seats utilised at the time of admission (average for three years, 1975-76 to 1977-78)	Out-turn (as % of admitted candidates)
IITs and IISc, Bangalore	6	2000 (22.70%)	1817	1117	91.00 %	61.50 %
Universities/University Departments	24	1953 (22%)	1560	766	80.00 %	49.00 %
Regional engg. colleges	13	779 (12.83%)	591	282	74.80 %	40.00 %
Non-government colleges	14	570 (9.40%)	481	245	84.00 %	51.00 %
State government colleges	14	632 (10.30%)	542	193	86.00%	35.80 %
Single-faculty institutions	3	171 (2.8%)	107	59	64.70 %	77.50 %
Total	74	6111	5098	2666		

Among the [illegible] with nearly 72.5 per cent of the students admitted to post-graduate degree courses completing the course. The position in [illegible] per cent, Kanpur 66 per cent, Bombay 66.8 per cent and Delhi 49.86 per cent.

[illegible] and Bangalore, Delhi, National Institute for Training in Industrial Engineering, Bombay, and the Indian [illegible]

Prof. K. Koteshwara Rao, Principal, Regional Engineering College, Warangal; Prof. G.N. Garud, Department of Electrical Engineering, Visvesvaraya Regional College of Engineering, Nagpur; Mr. A. S. Sekhon, Institution of Engineers (India), Punjab, Haryana and Himachal Centre; and Dr. K. Gopalan, Deputy Educational Adviser(I), Union Ministry of Education and Culture (member-secretary).

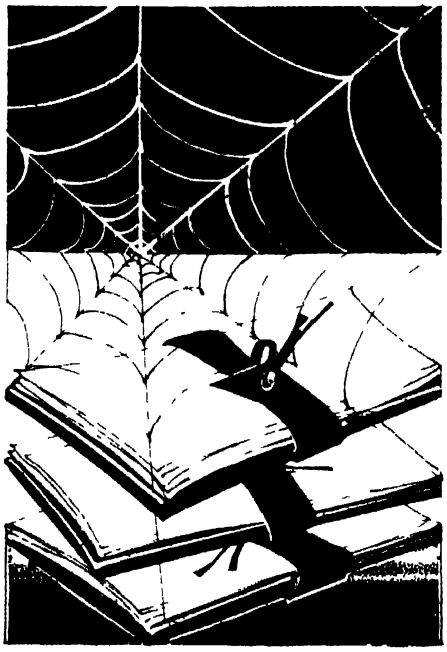
The committee had the following terms of reference: (1) to evaluate the progress made so far in the development of post-graduate courses and research in engineering and technology; (2) to review post-graduate programmes in university departments, IITs and other affiliated colleges and to recommend discontinuation of courses which are not relevent to national needs and to recommend areas of emerging interests for which courses may be organised; (3) to recommend norms and pattern of assistance for post-graduate courses in university departments, IITs and affiliated colleges; (4) to examine the advisability of concentrating post-graduate courses in selected institutions for better progress; (5) to consider the manner of achieving close co-ordination of post-graduate training and research with major developmental and engineering schemes in the country; and (6) to report on all other aspects of improvement and development of post-graduate courses.

For its study, the committee collected information, based on a questionnaire, from almost all post-graduate engineering and research institutions. The committee held meetings at Delhi, Bombay, Ahmedabad, Calcutta, Kanpur, Hyderabad, Coimbatore, Madras and Bangalore. It visited local institutions, and discussed the issues with teachers and students, representatives of industry and R & D organisations (the committee could not visit all the 74 institutions). At Delhi, discussions were held with senior officials directly responsible for the administration of R&D organisations and post-graduate institutions. The committee also invited views and suggestions from all concerned with these issues through advertisements in important national newspapers. And, in April 1980, before finalising the report, the chairman of the committee held discussions again with some senior policy-makers in the Union Government, including three members of the Planning Commission.

Despite this, the report has some limitations. "A serious problem the committee encountered was lack of reliable information on future manpower requirements," notes the report. "Thus it was not possible to anticipate areas of growth in S & T and make realistic projections on scientific and technical manpower development... Necessary data are not collected, much less updated, systematised and stored suitably for retrieval." Another important area where no reliable data were available was the pattern and trends in the utilisation of post-graduate degree holders in engineering and technology.

The following is an abstract of the committee's findings and recommendations.

During the last three decades, particularly after the Second Five-Year Plan, facilities for post-graduate education and research in engineering and technology have expanded considerably. While there were only six institutions before 1947, today there are 74, with an annual admission capacity of 6,111 (see Table on p 45). Though it cannot be easily quantified, about 63 institutions are offering doctoral programmes in engineering and technology, on an average, about 500 candidates register and about 350 qualify every year. Totally, India now produces about 350 doctorates, 2,700 masters in engineering (MEs) and masters of technology (M Techs) and 16,500 graduate engineers (in the ratio of about 1:8:47) annually, against intake provisions of 500, 6,000 and 26,000 (1:12:52), respectively. The corresponding enrolment figures in the 290 engineering institutions in the US for the fall of 1978 were 12,321, 26,060 and 95,805 (1:2:8), respectively.



It is often quoted that India is among the first 10 industrialised nations of the world, that she has the second or the third largest stock of scientific and technical manpower in the world. The fact is the science and technology content in the Indian society (as indicated by the national investment in this sector, number of technically qualified personnel, facilites for science and technology education, size of technical services, etc) as well as the extent of its involvement in R & D are incredibly low.

That vigorous measures are being taken for the creation of a sound scientific and technological base in the country by mobilising adequate resources is evident from the fact that expenditure on R & D has increased from a paltry sum of Rs. 1 crore in 1948-49 to about Rs. 450 crores in 1976-77. The expenditure on R & D which was 0.23 per cent of the GNP in 1958-59 has risen to 0.6 per cent in 1976-77. The expenditure on R & D as percentage of GNP was 2.1 in the UK (1972), 2.3 in West Germany (1974), 2.3 in the US, (1975), 2.5 in Japan (1975) and 2.7 in Poland (1975).

The diversification of scientific and technical knowledge is increasing immeasurably and fields of specialisation now number about a thousand. It seems desirable to recognise publicly and to publicise more widely that post-graduate studies are a normal part of engineering education. The unreasonably restrictive conception that a bachelor's degree is sufficient preparation for most engineering work should not be perpetuated. Of the total S & T manpower employed in the public sector R & D organisations in the country today, only 2 per cent are doctorates in engineering and 12 per cent master's degree holders. In the private sector, these figures are 1 per cent and 9 per cent, respectively. A sustained national programme should be launched to stimulate more widespread understanding among employers of the nature and importance of the engineering dimension and of the potential benefits to them from employing post-graduate engineers in a wide range of activities. Employing organisations should review their salary and career structures for engineers.

It should also be made mandatory to prescribe a post-graduate degree as the minimum qualification for recruitment to many positions in the engineering profession in industry, R & D organisations, electricity boards, public works departments, P & T, Railways, etc. The present policy and practice of recruiting graduate engineers at the lowest levels (single point entry) to many services including Railways, in the Bhabha Atomic Research Centre, etc should be done away with. As an incentive, it should be mandatory to give not less than two

Some welcome features

FROM the Third Five-Year Plan (1961-66) onwards, following the Thacker Committee Report in 1961, facilities for post-graduate education and research in engineering and technology were expanded considerably. Nearly two decades later, the Nayudamma Review Committee Report has not come a day too soon. The co-ordination, control, supervision and development of the entire gamut of post-graduate activities in engineering and technology remained vested in the All-India Board of Post-graduate Engineering Studies and Research which had been set up in 1962, at the instance of the Thacker Committee, under the aegis of the All-India Council for Technical Education. While this Post-graduate Board played its role effectively enough during the first decade following its establishment, its performance during the last few years has been far from satisfactory. It did not meet for years together; it still does not have a separate and competent secretariat. Consequently, funds to the tune of about Rs. 13.0 crores allocated for the development of post-graduate education and research during the Fifth Five-Year Plan could not be utilised.

Even though the Thacker Committee had specifically laid down that quality and standards should be the watchword of post-graduate courses, and that only students of the very best quality should be selected on the basis of their mental ability, maturity, aptitude for advanced work and capacity for concentrated effort, the Nayudamma Committee has observed that the failure on this front has been almost total and, consequently, standards in most institutions have fallen considerably; this is a matter of most serious concern, which will have far-reaching consequences on the country's future technological competence.

By far the most important single recommendation of the Review Committee is that the Government of India should make the AICTE/Post-graduate Board a new statutory organisation with powers vested in it by an act of Parliament to advance and promote the technological development of this country by maintaining high standards of engineering and technological education and research. The proposed authority should optimise the utilisation of all available resources and provide impetus to all the centres engaged in post-graduate programmes and research.

The committee recommends that "it is necessary to recognise publicly and to publicise widely that, in today's world, post-graduate studies at the Master's Degree level are a normal part of basic engineering education". The fact remains that, by and large, the present-day Indian industry—in both sectors—prefers to employ a bright BTech rather than a mediocre MTech, and to mould the former to its needs through in-house training on the job. A very similar situation prevailed in Britain not so long ago. It is also true that the industry today tends to pay its R & D engineers *much less than* engineers in its management cadre, and *less than* its sales and production engineers. On the other hand, it is next to impossible today to reasonably accommodate a PhD in engineering, with appreciable and relevant industrial experience within the pay-scales of institute/university faculty, even if such a person is willing, in a rare case, to switch over. Such a situation had never prevailed in Britain. It so happens, therefore, that by and large the PhDs stick to the universities while the BTechs run the industry; the two groups do not develop much confidence in each other, and both keep looking out abroad—the former for inspiration for, and topic of, research and the latter for the readymade panacea, namely, foreign collaboration. It remains to be seen if polite persuasion and concealed, or even explicit, compulsion, as recommended by the Review Committee, would serve to establish "firm linkages between the trinity: industry, research and education".

It is somewhat disconcerting to find the committee using the same term 'course' to indicate sometimes a single, specific subject of study and at other times a whole area of study. Tackling 'emerging (global) areas' like energy systems and engineering, information and communication systems, bio-medical engineering, etc in terms of 'courses', for which the existing norm of one professor and one assistant professor/reader per 'course' has been considered to be satisfactory, seems to be an extremely unrealistic proposition. Essentially, these are interdisciplinary, or trans-disciplinary areas, and the modern approach is to provide for an 'umbrella' laboratory set-up, with its own director—like the Energy Laboratory at the Massachusetts Institute of Technology, USA, which acts both as a catalyst for, and as a synthesiser of, the research activities of quite a large group of faculty members and graduate students drawn from various engineering and science departments, while the lecture courses preparing graduate students for work in the Laboratory are offered in the various departments.

In this context, the Committee's recommendation that, in the case of institutions of national importance, which are to be maintained and further developed as pace-setters, funding should be based on integrated infrastructural development as at present (subject to the rider that assistance to the various departments should be performance-based) is most welcome. Equally welcome is the Committee's emphatic recommendation that funding post-graduate education and research in engineering and technology in all engineering institutions, including university departments, must be totally a Central Government responsibility, thus eliminating all the existing dichotomies/disparities in funding.

On the eve of the introduction of the four-year B Tech programme in the country, instead of the five-year integrated BTech programme, the committee's call for an increase in the science content, including mathematics of the 10+2 higher secondary curriculum is a most timely one; for, otherwise, the science content of the BTech programmes will get curtailed and the growth of the emerging interdisciplinary areas will be jeopardised.

Some degree of caution, however, would need to be exercised in the winding up of 'unpopular' MTech programmes. Programmes in the area of electrical rotating machines, for example, have definitely been unpopular but, looking at the state of affairs in thermal power stations in the country, no one would deny that our national competence in the design of turbo-generators needs a good deal of upgrading. It is again the national malady of our industry prefering a 'sell-out' foreign collaboration to indigenous development, and of 'fashions' prevalent abroad dictating students' choice of programmes, that have primarily been responsible for the unpopularity of these programmes. If the BHEL could sponsor half-a-dozen projects in the academic institutions in the area of electrical rotating machines, it would most definitely serve to reverse the current trend in this area. Failing this, the country would very soon be bereft of any new entrants to this branch of electrical engineering.

In the committee's own words, the present review is the latest in a long pedigree of such official reviews, and there have been shortcomings in implementing them. Let us hope that the Ministry of Education and Culture, Government of India, which was adequately represented on the committee, would take prompt and vigorous steps to enact the required legislation which alone would give the necessary teeth to the recommendations made by the Nayudamma Review Committee.

K. C. MUKHERJI

Prof. Mukherji is with the Department of Electrical Engineering, Indian Institute of Technology, Bombay. He took his Ph D degree, specialising in applied electromagnetism, from London University in 1956 and worked for two years with Metropolitan Vickers Electrical Company in Manchester before joining IIT, Bombay, in 1958.

extra increments whenever post-graduate degree holders are recruited at the lowest level where the minimum qualification prescribed is a bachelor's degree in engineering A suitable number of advance increments should also be given to doctorate degree holders This is invariably done in advanced countries

Brain-drain and drop-outs

It has been stated time and again that only students of the very best quality should be admitted to post-graduate programmes Unfortunately, the failure on this front has been almost total and consequently the standards in most institutions have come down considerably This is a serious matter which will have far-reaching consequences on the future technological competence of this country The various views expressed to the committee showed that for a variety of reasons, which include redundant and outdated courses, inadequate facilities, lack of motivation, long duration of courses, lack of recognition and incentives, incompetent administration of the programmes, lack of employment opportunities, etc, it has not been possible to attract many bright young people for post-graduate education For similar reasons, even those who join these programmes leave sooner or later The drop-out rate has been 20 per cent to 100 per cent

According to certain studies about 25 per cent of the top engineering graduates from some of our best institutions leave the country every year The loss of the potential for innovative technology in this sort of brain-drain defeats the very purpose of higher technological education Strong and firm measures should be taken immediately to remedy the situation Only bright and motivated people should be admitted to post-graduate programmes The following measures are suggested

(a) winding up of all unpopular post-graduate programmes (which have not turned out any qualified candidates for three years consecutively and which were not able to admit five candidates or 50 per cent of the approved intake for three years consecutively), (b) improvement of physical facilities on the basis of revised norms, (c) institution of a common Graduate Aptitude Test in Engineering (GATE) to be designed and administered at the national level by an appropriate national agency, two or three times a year, at widely dispersed centres for admission to post-graduate programmes, (d) enhancement of scholarships for M Tech students from Rs 400 per month to Rs 600 per month, (e) enhancement of fellowships for doctoral aspirants from the present value of Rs 500 per month to Rs 700, Rs 800 and Rs 900 per month during the first, second and third years, respectively, (f) review of the values of all scholarships/fellowships once in every three years, (g) reduction of the duration of all M Tech level programmes from the present two years to three semesters—two semesters of rigorous course work, including core and elective courses and one semester of dissertation work invariably under two guides, one being preferably from industry, (h) encouragement of mobility and exchange of faculty between academic institutions, R & D organisations and industrial establishments, (i) making industrial experience as well as a doctoral degree or equivalent qualification



essential requirements for teaching positions at post-graduate level, with continuing studies made compulsory/mandatory (j) recruitment of teachers on an all-India basis and introduction of a rigorous staff appraisal scheme, (k) a specialist cadre of maintenance technicians engineers, at least on a regional basis, with proper status and adequate scales of pay comparable to those of other specialists (many costly and sophisticated equipment are neither maintained nor utilised properly), and (l) permitting institutions with proven competence for undertaking research projects sponsored by outside agencies to recruit and maintain a core of competent staff

Post-graduate courses in applied sciences now being offered in most places are not of good standard They should be critically reviewed There is also a need for increasing the science content of the 10+2 higher secondary curricula, and also for restructuring the first-degree(B Sc) programmes in science in such a way that these can be equated in status with the corresponding first-degree (BTech) programmes in engineering In many emerging areas, like computer science, opto-electronics, operations research, laser technology, etc, which are science-based but heavily technology-oriented, a separate stream of post-graduate programmes in the 'applied sciences', of three semesters, following the present-day Master's Degree in science, should be developed on the pattern of the M Tech programmes

There is increasing demand for part-time (evening) post-graduate programmes, especially in industrialised areas Introduction of part-time post-graduate programmes for working engineers on the basis of certain guidelines should be encouraged in institutions where full-time master's course in the subjects are already offered There is a real opportunity for innovation to facilitate high quality off campus instruction in India New techniques and arrangements should also be devised for extending high quality post graduate education to engineers/technologists employed at locations remote from established campuses

For achieving the much-talked-about and yet unrealised objective of institute-industry collaboration in an environment of interdependency between professionals in the industry and professionals in the academic world, the following measures should be adopted (a) faculty members should spend not only their sabbatical leave but also their summer in relevant industry (the National Associateship Scheme of the UGC which enabled teachers to spend up to 12 months in industry is not being utilised), (b) institutions should involve industry in the development of curricula on a regular and continuing basis, (c) the government should impose on industry and on government departments to sponsor their engineers and

technologists for post-graduate education and research, (d) requiring institutions to contribute towards continuing education of practising engineers by organising programmes, of not less than two months' duration, on the 'state-of the-art' as well as on advanced topics, designed in the form of 'modules' for various sectors of industry, government departments, defence services, etc, (e) introduction of sandwich co-operative programmes at the M Tech level (mention being made of the 'post-graduate collaborative programmes being offered by the BITS, Pilani), (f) putting eminent educationists/academicians on the boards of directors of industrial undertakings, and also placing captains of industry on the boards of governors and advisory bodies of academic institutions; also, involving the alumni in the work of the institutions on a continuing basis, (g) referral by the industry of their live problems to educational institutions, to be tackled as projects for M Tech/Ph D programmes with the entire costs to be borne by the industry—which should also come forward to institute fellowship/chairs for specific tasks, (h) inviting senior professionals in industry to offer specific courses of lectures at educational institutions at the post-graduate level, thus supplementing the core faculty at the institution, as is the practice abroad, (i) offering incentives, issuing directives and adopting legislative measures to ensure industry's involvement/investment in post-graduate education and research, like allowing a 133 per cent tax rebate on all payments/contributions/investments made by industry in post-graduate education and research, and levying a 'research cess' on each and every production agency, (j) clubbing/linking industries to educational institutions and encouraging industry to set up R & D production units in academic institutions, (k) inducing industrial establishments to make better use of the resources and expertise available within the teaching/research institutions through the consultancy and sponsored research services offered by the latter, by going even to the extent of levying a tax on any technical know-how imported by industry, (l) introducing part-time (including evening) and off-campus post-graduate programmes, and (m) making it mandatory to prescribe post-graduate degree as the minimum qualification for recruitment to many positions in industry, R & D organisations and government departments, while scrapping the present policy and practice of allowing only a single point entry at the lowest level for graduate engineers.

One of the main reasons for the degeneration of post-graduate programmes in engineering and technology in India has been the poor norms of funding these programmes. Consequently post-graduate activities have remained under-nourished and ineffective in most of the institutions. The courses have remained simple academic exercises unable to generate adequate R & D activities, which are necessary to train competent engineers in areas of design, development and innovations. Norms for funding post-graduate programmes should be revised on the basis of new guidelines.

While it is necessary to undertake in a phased manner the need-based consolidation of all institutions including modernisation of laboratories and replacement of obsolete equipment, consolidation should be done on a priority basis in selected institutions/departments, which, despite poor funding, have proved their merit. These institutions/departments should be subject to close scrutiny by competent visiting committees with a view not only to consolidating, but also to identifying the expertise they have achieved in emerging areas of national relevance and to promoting them as centres of excellence/advanced studies They should serve as nuclei for technological development in their respective regions. A provision of about Rs. 20 crores may have to be made for the purpose during the Sixth Five-Year Plan (1980-85).

The disparities in the pattern of funding post-graduate programmes have created lots of problems, particularly in the university departments under the control of the UGC The portion of post-graduate grants released to the university departments of state universities through the UGC (with the complicated condition that the concerned state governments should take over the responsibility of funding after five years) is a small fraction of the total expenditure incurred by the Central Government on post-graduate education and research in engineering and technology. It is recommended that funding post-graduate education and research in engineering and technology in all engineering institutions, including university departments, should be totally done by the Central Government.

In the case of institutions of national importance, which are to be maintained and further developed as pace-setters, funding should be based on integrated infra-structural development as at present. However, even in these cases, assistance to the various departments should be performance-based.

One of the biggest stumbling blocks in the path of scientific and technological research and development in India has been—and is—the lack of proper data banks/information services. There is immediate need to educate and train information users by introducing user education/training programmes in the post-graduate institutions and research centres. A suitable national agency should undertake this responsibility in collaboration with INSDOC, NISSAT, etc. It is recommended that a couple of National Data Centres with all the major S & T data bases in the form of computer-readable tapes should be established in the country on a top priority basis on the lines of one set up in 1979, at Vallbonne , near Nice, in France Also, suitable programmes would need to be developed for educating and training information users.

Administration and evaluation

The factor which has been primarily responsible for almost all the ills of post-graduate education and research in engineering and technology in India today has been the failure of the administration—the AICTE/Post-graduate Board—to implement the recommendations not only of the committees appointed by it, but also of its own. This committee, therefore, recommends that the Government should make the AICTE/Post-graduate Board a new statutory organisation—a National Authority—with powers granted to it by Parliament to advance and promote technological development by maintaining high standards of engineering and technological education and research. In fact, this was recommended two years ago by the Estimates Committee of Parliament.

Planning, organisation and prescription of standards for post-graduate education and research programmes in universities, IITs, Indian Institutes of Management and affiliated colleges should be co-ordinated by the proposed National Authority, which should have a separate full-time secretariat with suitable administrative, executive and financial powers. Evaluation and accreditation of post-graduate courses should be done at least once in five years. For this purpose, a National Evaluation and Accreditation Agency should be established. Methods should also be developed for the performance audit of institutions engaged in post-graduate education and research to facilitate comprehensive reviews of the various programmes. The general practice of financial expenditure audit should be done away with.

I.I.T. ENT. EXAM. 1980

Outstanding results from students of Agrawal Classes in each Zone!

This year again our students have done extremely well. From each zone, the top rankers had taken our course. Leading them is P. PANDURANG NAYAK of Bombay who stood FIRST IN INDIA.

WEST ZONE

	NAME	PLACE	ZR*
1.	P. Pandurang Nayak	Bombay	1st
2.	Anoop Chawla	Indore	3rd
3.	Fersosh P. Mistry	Bombay	4th
4.	Vishwanath Chidambaram	Bombay	5th
5.	K. Mahesh	Pune	6th
6.	Chaitan S. Khosla	Pune	7th
7.	Deepak N. Hoshing	Bombay	8th
8.	Meelan M. Choudhari	Bombay	9th
9.	Amrishkumar G. Agrawal	Bombay	11th
10.	Rajanish V. Jain	Bombay	12th
11.	Deepak S. Gulrajani	Bombay	13th
12.	Mani Sundaram	Bombay	14th
13.	Rajendra Agarwal	Ajmer	15th
14.	Umesh R. Dhond	Bombay	16th
15.	S. Naresh Kumar	Pune	17th
16.	Kubsad Prakash	Pune	18th
17.	Amarnath G. Bhide	Bombay	20th
18.	Dinesh V. Kocharekar	Bombay	21st

NORTH ZONE

	NAME	PLACE	ZR*
DELHI			
1.	Manoj Kumar Mittal	New Delhi	2nd
2.	Anand B. Rao	New Delhi	4th
3.	Rajiv Laroia	New Delhi	6th
4.	Sanjay Ranka	Udaipur	11th
5.	Raghuram G. Rajan	New Delhi	13th
6.	Sanjay Mittal	New Delhi	18th
7.	Ranjeet Mehta	Faridabad	19th
8.	C. Vivekanand	New Delhi	21st
KANPUR			
1.	Pawan Kumar	Kanpur	10th
2.	Vachaspathi Kompella	Hyderabad	11th
3.	Prashant Gaur	Allahabad	13th
4.	Vikram Mukund Odak	Kanpur	14th
5.	Anoop Kumar	Patna	19th
6	Sanjeev Kumar Rastogi	Lucknow	21st
7.	Sunil Kumar	Patna	24th
8.	Nikhil Nigam	Kanpur	25th

EAST ZONE

	NAME	PLACE	ZR*
1.	Deeptendu Majumdar	Calcutta	4th
2.	Surya Mantha	Ranchi	5th
3.	Siddhartha Chatterjee	Calcutta	7th
4.	B. Venkataramanan	Calcutta	8th
5.	Susanta Basu	Calcutta	9th
6.	P. Krishna Kumar	Ranchi	14th
7.	Soumitra Bose	Jamshedpur	15th
8.	Somak Ray Chaudhary	Calcutta	17th
9.	Ben V. Verghese	Calcutta	18th
10.	Rajendra V. Kulkarni	Bangalore	20th
11.	Devdip Purkayastha	Shillong	21st
12.	Subhendu Ghatak	Kharagpur	23rd
13.	Ramesh Subramonian	Calcutta	24th
14.	Miss Swagata Banerjee	Ranchi	26th
15.	Sukanta Kumar Nanda	Cuttack	29th
16.	Sanjib Kumar Roy	Rahara (W.B.)	30th
17.	Gautam Basu	Calcutta	31st

SOUTH ZONE

	NAME	PLACE	ZR*
1.	V. Venkateswar	Nalgonda	3rd
2.	V.S. Mani	Madras	4th
3.	V. Chandramouli	Bangalore	6th
4.	S. Srinagesh	Madras	7th
5.	C. Vijay Anand	Madras	8th
6.	Rajesh Gupta	Bangalore	9th
7.	B. Mahesh	Madras	10th
8.	S. Raghavendra Prasad	Bangalore	14th
9.	R. Chakharapani	Madras	15th
10.	K. S. Raghavan	Rishi Valley	16th
11.	C. Sajai Krishnan	Madras	20th
12.	Guha Seshadri	Madras	22nd
13.	P. Sridhar	Vizag.	23rd
14.	R. Karthik	Madras	24th
15.	V. Venkataraman	Madras	26th
16.	V. Krishnamurthy	Bangalore	27th
17.	Phaneesh Murthy	Bangalore	31st
18.	V. Ravi	Bangalore	33rd

*Zonal Rank

AGRAWAL CLASSES
Correspondence Division,
202, Prasad Chambers, Bombay 400 004

The dog-bite madness

A. N D Nanavati

Can we do away with rabies? Many countries have eradicated rabies, while in India it still poses a serious problem



A series of injections is given in the abdomen

DURING the sweltering days of summer, you may see the municipal staff of your town chasing stray dogs stuffing them into gunny bags and later carting them away to their doom by electrocution. You may be moved by their piteous whining but it is as well to remember that they may give you a dreadful and fatal disease rabies or hydrophobia.

Ferdinand Raimund a famous Austrian actor and playwright shot himself in 1836. He took his life not because of a love affair or professional failure but out of fear of something. He had been bitten a day earlier by a rabid dog.

The agony which a person undergoes on being bitten by a rabid animal has been very graphically described by an Italian physician in 1546. He recorded: "The patient can neither stand nor lie down like a madman he flings himself hither and thither tears his flesh with his hands and feels intolerable thirst."

No wonder the Greeks called the disease *lyssa* (frenzy) and the Romans used the word *rabere* (to rage) from which the word rabies is derived.

Indeed rabies has affected the human race for centuries and several measures for its control and eradication have been tried from time to time. As far back as about 1800 BC the Mesopotamian *Laws of Ishnunna* enjoyed: "If a dog is mad and the authorities have brought the fact to the knowledge of its owner if he does not keep it in and it bites a man and causes his death then the owner shall pay two thirds of a *mina* (40 shekels) of silver. If it bites a slave and causes his death he shall pay 15 shekels of silver."

Since it is difficult to make out whether a stray dog is rabid or not health authorities in most countries have considered it a safe policy to get rid of all stray dogs. Another method has been to develop more and more effective vaccines against the disease.

Rabies is a viral disease. It attacks the central nervous system of all warm blooded animals leading to hyper irritability followed, in some cases by paralysis and coma. Death usually follows in two to five days.

Stray dog menace Bombay's example

THE population of stray dogs in Bombay city is very large. The Public Health Department of Bombay Municipal Corporation (BMC) has speeded programme of dog licensing and destruction.

The dog licensing establishment is primarily concerned with decreasing the number of stray dogs which are the main carriers of rabies by organising dog catching raids. The stray dogs are caught by roping using the stick loop method. This gang comprises one dog catching sub inspector in five localities each in different wards. The stick loop method consists of first cornering and surrounding the animal and then quickly pushing it with a thick stick and even chains into a huge gunny sack. The dog is then taken to the kennels at Mahalaxmi where it is kept for three days. If in this period the dog is not retrieved by its owner or interested parties, it is killed by electrocution. The official figure of the average dog-catch is 3,500 per month. Licences are also issued for dogs and facilities for their immunisation against rabies exist.

Tables 1, 2 and 3 give the budget estimates for the dog control programme.

Table 1

Financial requirement for licensing

	Actuals (1978-79)	*Revised Estimates* (1979-80)
Activity		
Destruction of dogs and maintenance of dog-catch vans	5 40 727	8 60 000
Licensing of pet dogs	2 57 559	3 36 000
Immunisation of dogs against rabbies	2 440	4 000
	8 00 726	12 00 000

Table 2

Programme work load summary	*Actuals* (1978-79)	*RE*
No of places raided	10 216	11 000
No of dogs caught	45 895	38 500
No of dogs destroyed	41 351	35 300
No of dogs supplied free to research institutes	393	400
No of dogs sold to private parties	411	400
No of dogs released	2 407	2 400
No of complaints	5 635	4 500
No of dogs detained and fed in kennels	42 694	35 000
No of licenses issued renewed	16 982	17 000
No of dogs immunised	326	3000

Table 3

Personnel summary	*Actuals* (1978-79)	*RE* (1979-80)
Activity No 1		
Supervisors clerks dog catching sub inspectors	19	19
Dog catching labs junior overseers kennels and kennel bigaries	76	76
Activity No 2		
Junior overseers	13	13
	108	108
Revenue		
Public Health Department tax on dogs	1 58 340	1 50 000
Expenses		
Dog licensing and destruction	8 00 726	12 00 000



Rabid dog showing the symptoms of the disease. Once the symptoms appear, the dog's days are numbered

In man, the characteristic symptom noticed first is an inability to swallow liquids, though solids like biscuits can be eaten without difficulty. After a few hours, attempts to swallow water cause spasms of the throat muscles, which becomes so painful that the patient shrinks away in terror, even at the sight or sound of water. However, this fear of water, or hydrophobia, so characteristic in man may not be found in animals, and dogs have been known to drink water till the time of death. The victims may later become unconscious, but mostly they remain conscious and clearly aware of their fate till the end—a fact which makes the disease even more terrifying.

The principal carrier or vector of the disease in India is the dog, and the disease is transmitted through its saliva when it bites. The susceptibility of various animals to natural and artificial infection with the rabies virus varies from species to species. Skunks, opossums and fowls are highly resistant, whereas foxes, cats and cattle are highly susceptible. Human beings and dogs come in between.

In many parts of the world, wild animals are known to transmit the disease. The spotted skunks (*Spilogilae putorius*) transmitted rabies in lower California during the 19th century; and recently, the skunks (*Mephitis mephitis*) have come to account for more than half the rabies cases reported in the USA. Today the red and the gray fox, and not the dogs, are the primary reservoir of rabies in Europe.

Rabies is also transmitted by bats. Even today, in Latin America, bat rabies kills hundreds of head of cattle annually. Human deaths due to bites by bats which subsist on blood diet were recorded in the early 16th century, and there have been many legends of vampire bats (Bram Stoker's novel *Dracula* is about a vampire), though the proof of the bat as the carrier of rabies was obtained only 50 years ago. Attacks on whole human populations by rabid insectivorous bats have also been reported, involving more than 50 species of bats spread over the USA and South America.

Bats can also transmit rabies to animals and man without biting. The disease can be acquired by inhaling the infected air in an enclosed area like a cave. The rabies virus has now been isolated from air samples from caves inhabited by bats.

Most carnivorous animals lick their paws constantly, so even a scratch from the claws (even of a pet animal), which we normally tend to ignore, can be dangerous. The virus cannot penetrate the unbroken skin, but can pass through the mucous membrane lining the cavity of the mouth, eyes and nose. Hence, a lick on the face, or on a freshly injured skin, can also be infectious. In all such situations a person is considered exposed to the risk of infection. Any rabid animal and even human beings carrying the virus can transmit rabies.

Official estimates in India give 1,000 to 1,500 deaths per year as due to rabies. This is indeed a small figure when compared to other killers like tuberculosis, gastroenteritis and tetanus. But the public health authorities have tended to play the problem down, notwithstanding that many cases of rabies are never brought to their notice.

The specific preventive treatment against rabies is vaccination. The standard modern treatment entails administration of the vaccine by 14 daily injections in the stomach, which is a soft tissue and is less exposed to direct pressure than other parts. The vaccine is prepared from the brain of a sheep infected with an attenuated rabies virus, that is, a virus which has been rendered less virulent by appropriate treatment. One sheep yields enough vaccine to treat 10 to 15 persons. Rabies vaccine is produced at nine institutions in the country, having a total capacity of about 40 million millilitres per year. Even this production is inadequate and there are chronic shortages of vaccine.

There are several reasons for such shortages. For one thing, the vaccine is potent for only six months from the date of production. Of this period, a minimum of two months is required for control test procedures. In effect, when ready for release, the vaccine



usually has a life of no more than 3½ months. It cannot, therefore, be prepared in bulk and stored, but has to be produced continuously, on a daily schedule, which often gets disrupted.

Most production laboratories are working near the limit of capacity, and any hindrance can seriously affect the production schedule. Such setbacks occur due to shortage or poor health of the sheep; they may die prematurely and hence cannot be used for vaccine production. During the monsoon, for instance, all these factors may operate simultaneously and the actual production may be hardly half the total capacity.

Meanwhile, the demand for anti-rabic vaccine is increasing. The trend today is to vaccinate a large segment of the population which may not really be at risk—for one cannot take chances with a fatal disease like rabies. Stray dogs bite or scratch when they sense danger or are provoked. And it is difficult to say whether a stray dog is rabid or not unless it is caught and placed under observation. In Greater Bombay alone, 75,000 to one lakh people are vaccinated every year, though 80 to 90 per cent of these are not exposed to infection.

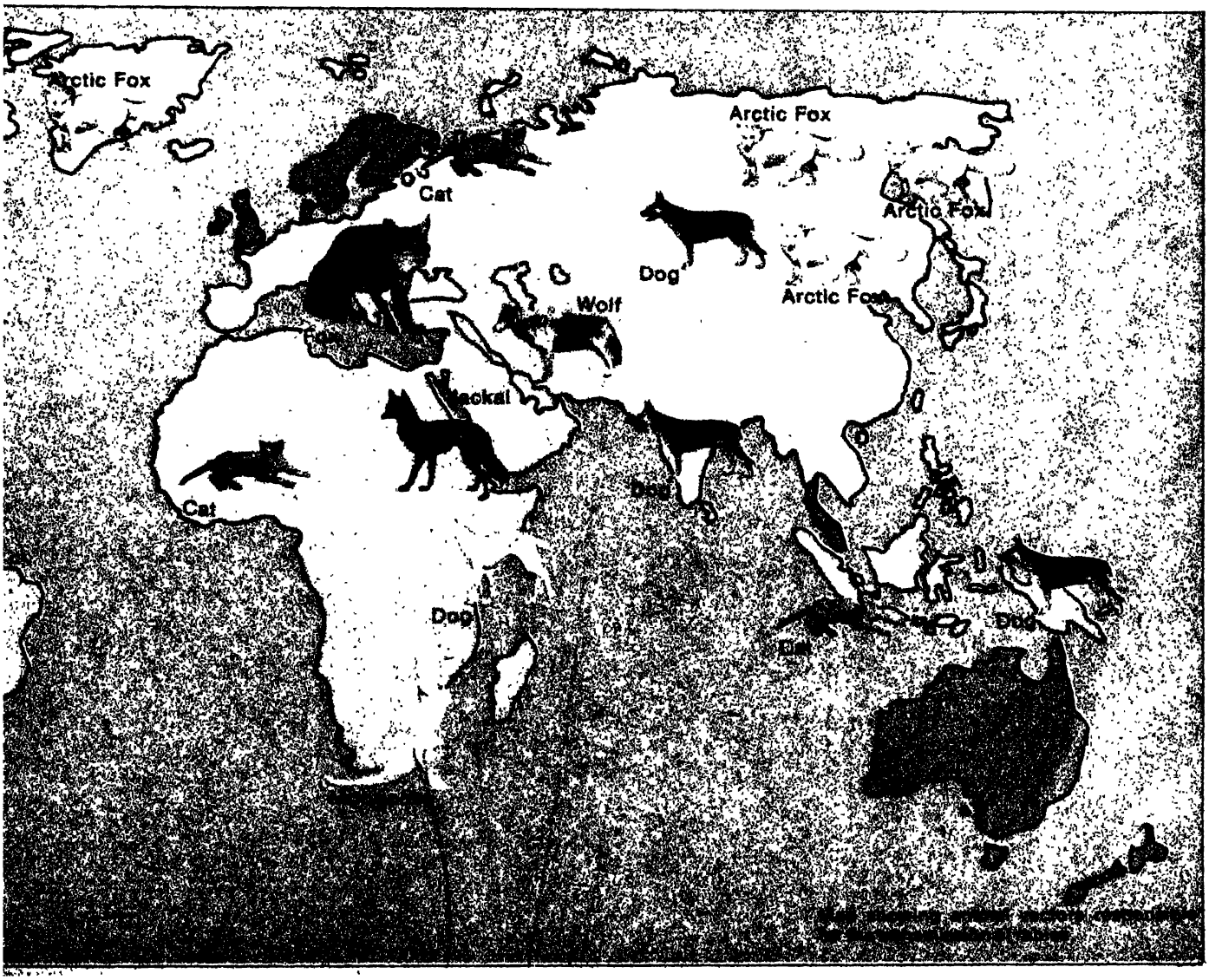
But in rural areas, many persons, whether aware of the risk or not, do not take the treatment because the nearest centre may be more than a day's journey away. Even if it is closer, the patient has to travel to the centre daily or to arrange to stay for treatment at the centre. That could mean loss of wages for 14 days, and this the average villager cannot afford. He may take a fatalistic attitude and perhaps resort to charms and mantras. In recent years, with the spread of medical services to rural areas, many villages have a Primary Health Centre with a refrigerator in which the vaccine can be stored. With treatment being more easily available, the villager opts for it more readily, pushing up the demand for the vaccine.

Even if the production is double the estimated demand of vaccine, this will not eliminate shortages altogether This would also mean that up to half the production may remain unused or have to be discarded when it becomes out of date. If we estimate the cost of the vaccine at about 25 paise per millilitre (ml), discarding vaccine equal to our present production that is 40 million ml, would amount to a waste of Rs. 10 million.

It seems ridiculous to add such a burden to the health budget, particularly when most of the vaccine is not really required. At the same time, we cannot deny vaccine to those who need it. In recent times, many hospitals have been unable to obtain vaccine for two months or more, and have had to turn away patients known to be exposed to almost certain death.

Thus rabies, though a relatively minor health hazard in terms of deaths, inflicts a heavy traumatic toll on the victim and his family. It involves a huge expenditure and the labours of highly trained scientists on the production of vaccine which may not be used.

What is to be done? Eradicating



rabies is not difficult. The measures necessary have been known and successfully applied for over a century in different countries Since, in India, human rabies is predominantly caused by dogs, or by other pets or domestic animals—infected, in their turn, by dogs—the best way out would be to remove the reservoir, the stray dog Destruction of all stray dogs and the compulsory vaccination and licensing of all pets are already required by law, but the law is never strictly enforced That it can be done has been shown by countries with even smaller technical resources than India

Malaysia, for instance, carried out eradication measures (shooting of stray dogs by sharp shooters etc) in 1952 and has been free of rabies ever since In Australia, Antarctica, New Zealand, Hawaii, the UK, Ireland and Scandinavian countries (excluding the border region of Denmark), the disease has been wiped out by controlling the stray dog population But since World War II, after the stray dogs have been eliminated, other animals have become carriers In India, elimination would involve careful organisation and planning, and may take three years or more to achieve the desired objective But the expenditure would be compensated by the savings on the vaccine pro-



Children are particularly at risk All families should have their pet dogs and cats vaccinated

duced and on the clinics which administer it

There is a pressing need for research on a better antirabic vaccine The present vaccine has several drawbacks, the most important being that the treatment is too long and cumbersome to be effectively delivered to many who need it the vaccine is difficult to prepare, it requires constant refrigeration, it has a short shelf-life, in addition, it can occasionally cause severe side-reactions, resulting in paralysis or even death Therefore, a better vaccine would be one free from these disadvantages and would be effective with fewer injections Such vaccines are already being prepared experimentally

Before adopting a new vaccine, it is necessary to establish its efficacy and safety by comparing the results among persons vaccinated with the new vaccine with those receiving the old vaccine In the case of rabies, failure of the vaccine is likely to result in death, hence there is an understandable reluctance to try an unknown vaccine on humans However, in India, a considerable number of the rural population refuses the standard treatment as they cannot afford it Such people could be offered, as an alternative, a vaccine which requires fewer injections Only after some years, when a sufficient number of people have received the new vaccine, can a comparative assessment be carried out

India has both a large number of subjects who require the treatment, and a large pool of trained personnel to carry out these studies And no other country faces the problem on such a large scale A proposal, with a detailed outline for such a study, has been placed before the Indian Council of Medical Research and it is to be hoped that the Council will support it

Dr Nanavati who retired as the head of the Virology Department Haffkine Institute Bombay was actively involved in different aspects of rabies research and the production of its vaccine He is also interested in ecology and nature conservation and is Honorary Secretary of the Bombay Natural History Society

TELEDYNE PHILBRICK

ALLIED DRIVE AT ROUTE 128
DEDHAM MASSACHUSETTS 02026

TELEDYNE EXPANDS BY INTRODUCING

4857 S H Amplifier
Features: Aquisition Time 1 μsec Guaranteed.
Ultra Low Droop Rate 0.1 μv μs Typical.
Temp. Coeff. : 5 ppm C max. for Gain.
100 μv C max. for Offset.
Settling Time : 0.125 in 500 nsec (20V step).
Temp. Range : 4857 0 C to 70 C
4857-80 55 C to 125 C
4857-83 55 C to 125 C
Mil Spec.-Mil-Std-883
Internal Buffer—for Inverted Non-inversion.
Also available high reliability
*** Operational Amplifiers**
*** A D, D A Converters**
*** V F, F V Converters**
*** Power Supply Modules**
For high accuracy and reliability depend upon Teledyne Philbrick. Contact for product catalogue :

Sample Hold Amplifier Family
4857 High Speed S H Amplifiers
4855 For Data Aquisition
*** 4855 : 250 nsec Aquisition Time S H Amplifier Module**
*** 4856 : Low-cost Microcircuit S H Amplifier Dip Package**



1461 Fast High Power Fet OP.
750 MHZ Gain Bandwidth Product.
± 30V 0.6A Output.
1200V/μsec Slew Rate.
10 MHZ Operating Bandwidth.
Fully Differential Input
V MOS Output Stage.

ELECTRONIC ENTERPRISES

REGAL INDUSTRIAL ESTATE, UNIT 216, 2ND FLOOR, ACHARYA DONDE MARG, SEWRI, BOMBAY 400 015

If...



...there was no moon

A MOONLESS night may not be so romantic, but then, the moon provides more than just moonshine A multiplicity of phenomena and feedbacks can be traced to the presence of the moon For example the tidal force Because of its proximity, the moon is responsible for the major part of the tide raising force on earth However even without the moon we would have tides in the ocean the sun's tidal force, though small when compared to the moon's is not insignificant It is slightly less than half that of the moon Therefore the tides would be smaller too

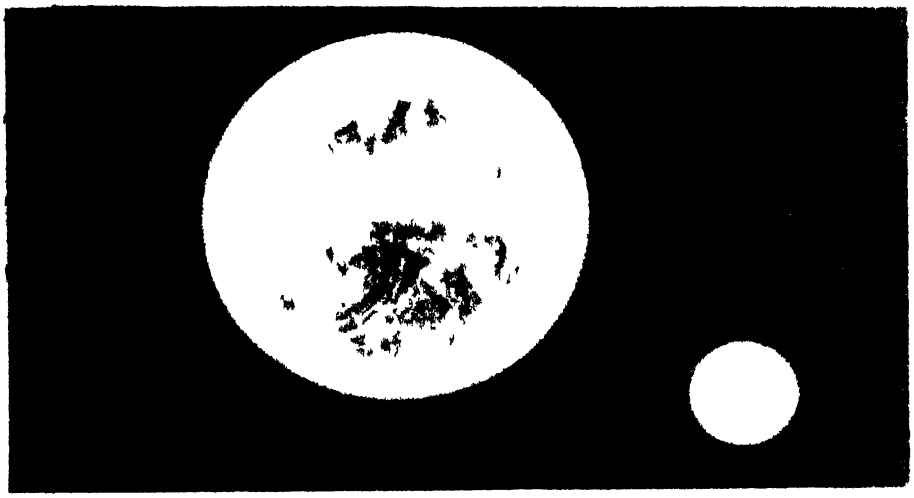
The tides however affect the motion of the earth by generating a frictional force and result in slowing down its rotation The drag of tidal friction which slows down the earth's rotation is equivalent to an energy dissipation of over two billion horse power Due to this each day becomes about five hundred millionths of a second longer than the previous day It is estimated that the duration of a day on earth was about ten hours or so billions of years ago (when the moon was very close to earth) and that it is due to the tidal friction caused by the moon that we have now a 24 hour day Some scientists estimate that about four billion years ago both the day and the month on earth were even shorter about five hours each

Having a ten hour day can be catastrophic for earth Apart from the biological impacts the short day will result in a climatic condition entirely different from that of the present Before the earth even warms up during the day night will fall and cause further cooling

If the difference between high and low tides is very small the shore levels of the oceans will not vary very much over a day When the moon was much closer to the earth in the past its tidal force was also quite high and the differences between high and low tidal levels were correspondingly higher

In a sense, the moon was responsible for the evolution of air breathing land-living animals Geological records point out that over a billion years ago all animals lived in the seas Due to the frequent variations in the level of ocean waters caused by the lunar tides and the consequent changes in the shore lines many sea living animals were left behind on the shores without water during low tides for an appreciable amount of time Most of them died and a few that could survive the waterless shores due to their having developed some sort of lungs to breathe air became the amphibians and they in turn led to the evolution of the air-breathing reptiles and mammals But for the presence of the moon land animals would not have evolved and all forms of life may still have been found only on water

If the proximity of the moon ushered in life on land it will also lead to its death The moon will continue to slow down the earth and after billions of years both day and months will be equal to 47 of our present days When the moon approaches



the earth as it will eventually and reaches the distance within the Roche limit it will be torn apart The debris will form a ring around the earth But most probably nobody will be around to see the spectacular ring Before that due to the proximity of the moon large tidal waves within the earth's interior will trigger gargantuan earthquakes and volcanic eruptions and all life may perish

Provided the sun does not change by then a moonless earth will constantly present the same face to the sun The sun will always shine on one half of the earth which will be hot and desert like The other half will be under perpetual darkness and will be covered with massive ice sheets

Without the moon, some of the activities of the flora and fauna that rhyme with the daily cycles of light and darkness high and low tides and the waxing and waning of the moon will be thrown out of gear

It is interesting to compare the planets with and without the satellites Mercury is a small planet closest to the sun and it does not have any satellite It is extremely hot during the day and very cold during the night Mercury has neither atmosphere nor life Venus is a planet like the earth but again it does not have any moon It rotates rather slowly and has a hot surface due to the abundant carbon dioxide in the atmosphere Mars has just two tiny moons—Phobos and Deimos—and the planet does not have much of an atmosphere (1/100 earth's atmosphere) and no evidence for any form of life Beyond Mars there are the giant planets like Jupiter Saturn, Uranus and Neptune These planets have a large number of satellites They are too cold and gaseous to have any chance of advanced life Recently Pluto also has been found to have a moon but not much is known about the planet It is now believed that Pluto may also be a gaseous planet

Earth is unique in having just one moon and it is probably the only planet in the solar system to have life Is it coincidence or is it in some way due to its solitary satellite?

On a more philosophical level a world without the moon will be less romantic and less intellectual It is the moon that inspired people like Plato and Aristotle to formulate great theories of the universe Newton's law of universal gravitation was checked by the motion of moon Again Jules Verne's imagination and the realities of Apollo astronauts landing on the moon would be absent

V S VENKATAVARADAN

Dr Venkatavaradan is Director of the Nehru Planetarium Bombay



Calmodulin

Nirmala Maheshwari

Kusum Malhotra

In specific amounts calcium regulates a variety of body functions. How does it fit in all these roles? Scientists have found the master key

IN THE world of cell biology, the recent discovery of Calmodulin, a calcium-binding protein, is as exciting a discovery as that of recombinant DNA. Calcium ions have long been implicated in the control of a wide range of fundamental cell activities. For example, when a nerve or muscle cell is stimulated or when an egg is fertilised, one of the first events to occur is a marked increase in the concentration of free calcium ions in the cell. This increase apparently triggers an appropriate response, such as muscle contraction or release of the nerve's chemical transmitter. Calcium is actively involved in the control of certain cellular movements, like moving apart of the chromosomes during cell-division, and in the movement of the cilia or flagella that propel sperm and many single-celled organisms. Its activities also range from the regulation of glycogenolysis (a process in which glycogen, a polysaccharide found as reserve carbohydrate, is split to form glucose) and gluconeogenesis (the synthesis of new glucose molecules by breakdown of fats and amino acids). However, despite a large body of evidence supporting the involvement of calcium in so many diverse processes, very little was known about the way it worked. The discovery of a calcium-binding protein—calmodulin—has now given a clue about the role of the element in cell activities.

According to Thomas Vanaman of Duke University Medical Center (USA) calmodulin "regulates everything in the cell from division to movement to secretion". It has been found in all nucleated cells examined so far, be it single-celled organisms such as *Tetrahymena pyriformis*, *Paramecium* or a higher plant cell or a human brain cell. Though this protein has not yet been detected in simpler, non-nucleated bacterial cells it is speculated that even they may have some related substance.

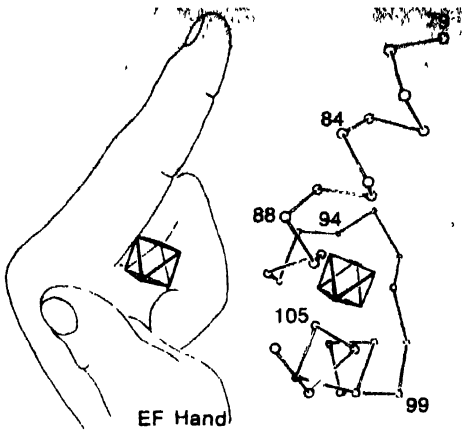
Discovery

Calmodulin was discovered accidentally. Cyclic nucleotides, cyclic AMP (adenosine 3', 5'—monophosphate)' and cyclic GMP (guanosine 3', 5'—monophosphate) were known to play important regulatory roles in many biological functions, for example, the control of hormone action. The tissue levels of cyclic nucleotides are governed by the activity of the enzyme phosphodiesterase which brings about their hydrolytic destruction. But, in 1970, while purifying bovine-brain phosphodiesterase, Wai Yiu Cheung of St. Jude Children's Hospital, USA, made the interesting observation that the crude enzyme, which was fully active, lost most of its activity upon purification. But the purified enzyme could be made to regain its full activity by incubating it with snake venom. This suggested that some factor, probably an activator, was getting dissociated during the purification step. After a great deal of research, Cheung's group did succeed in isolating an activator, which effectively restored the activity of the purified enzyme.

Around the same time, S. Kakiuchi and R. Yamazaki, working in the Nakamiya Mental Hospital, Japan, independently isolated a similar protein factor from the rat brain, required for the activation of the same enzyme, and named it "phosphodiesterase activating factor" (PAF). J. R. Dedman's group from the Department of Cell Biology, Baylor College of Medicine, Texas, USA, also isolated a Ca^2 dependent regulator protein from rat testes which they referred to as Ca^2 dependent regulator (CDR) Eventually, when the structure and properties of all these protein factors, variously referred to as activator PAF and CDR, were compared, they turned out to be so similar that they were bunched under a common name, calmodulin. The name was proposed by Wai Yiu Cheung because it modulates the activity of calcium.

More recently, it has been shown that calmodulin mediates the effect of calcium not only in the enzyme phosphodiesterase but in many other enzymes which regulate various metabolic processes in a cell.

The sarcoplasmic reticulum (SR), which may be in the shape of sacs, tubules or circles, acts as a storehouse of calcium and, on stimulation of the muscle cell, slowly releases these ions into the cytoplasm. The calcium pump of the SR removes the ions from the cytoplasm to terminate contraction. If calmodulin happens to stimulate this pump, then the same regulatory protein that acts to initiate contraction may help to turn it off. Calmodulin is indeed a multifunctional enzyme regulator.



The "EF - hand", a basic structural unit prevalent in many calcium-binding proteins. The F helix constitutes the extended thumb, and the E helix is the index of the hand The oxygen binding site is denoted by the octahedron

Properties and structure

Calmodulin has been purified to apparent homogeneity from bovine serum, heart and other tissues by the standard procedures of protein purification. The purified protein has 100 times more specific activity than the crude homogenate. The compound is heat-stable and is sensitive to proteolytic enzymes but not to RNase and DNase, thus ruling out the association of any nucleic acids in its structure. The protein is resistant to eight molar (8M) urea and to boiling at pH7. Calmodulin is a relatively small protein, made up of 148 amino acids and has a molecular weight of 17,000 daltons. It has a high content (30 per cent) of glutamic and asparatic acids and a low level of aromatic amino acids. This can explain its high affinity for calcium. Analyses of the amino acid sequences of calmodulin obtained from various sources show that the structure is highly conserved and has come down almost unchanged during the course of evolution. At least, throughout the animal kingdom, from the lowest invertebrates to the human brain, there are very few changes in its amino acid sequences. T. C. Vanaman, who has worked out many of these amino acid comparisons suggests that the conservative nature of the protein can be attributed to its interaction and close co-operation with diverse enzymes and other proteins which are essential to life. Cal-

modulin has a fairly high amount of phosphorus (10 moles of phosphorus per mole of protein) and calcium appears to bind to the phosphate groups as evidenced by the loss of binding activity following treatment with enzyme phosphatase. It lacks tissue specificity; that is, calmodulin from one source readily acts as activator for an enzyme in another tissue.

The protein has four binding sites for calcium, comprising four roughly identical sections of the chain (domain). The binding occurs in a specific ordered sequence, with each addition producing its own conformational change. This helps different enzymes recognise various conformations. In this way, calmodulin can translate the quantitative information of varying calcium concentrations into diverse responses. Each changed shape of calmodulin is like a key that fits specific receptor sites on a wide variety of enzymes and cell membranes, activating them to perform their respective functions.

Calmodulin has physico-chemical similarities to the calcium-binding subunit of troponin, a muscle protein. Troponin can even be substituted for calmodulin in the activation of phosphodiesterase, although a 600-fold high concentration is required.

The three-dimensional structure of another calcium-binding protein—parvalbumin—was determined about five years ago by Robert Kretsinger of University of Virginia, USA. This protein was found to have three domains, all having again similar spatial arrangements of their atoms. Each domain consisted of two alpha helices, both having ten amino-acid residues, separated by a nonhelical loop that contained the actual calcium-binding sites. Since the helices were arranged like the hand's extended index finger and thumb, Kretsinger called this structure the "EF hand". As predicted by scientists, this, in general, has been found to be the basic structural unit of calcium-binding proteins. The four domains of calmodulin and troponin-C are indeed EF hands.

Using radioimmunoassay it has been shown that calmodulin is present in the cytosol. It attaches temporarily to the enzyme it activates. However, recently it has been reported that in skeletal-muscle, it is a stable subunit of the enzyme protein phosphorylase kinase and not a detachable activator.

Mechanism of action

Calmodulin works like an intracellular calcium receptor and binds to calcium ions when their concentration increases in a cell in response to a stimulus. This binding brings about a conformational change in the molecule as a result of which the calmodulin-calcium complex becomes capable of binding to any of the several enzymes it activates. When the enzyme is activated, a chain of biochemical reactions is set in motion which then produce the response. Not only can calmodulin affect cell activities in this direct manner, but, indirectly, it is also known to affect the concentration of calcium itself and that of other important cellular regulators like cAMP.

But how can one single protein do as many different things as calmodulin? How does it decide what to do and when? Apparently, different enzymes recognise different conformations of calmodulin and this simple property regulates the switching-on of enzymes at different times.

Dr (Mrs) Nirmala Maheshwari is a lecturer in the Botany Department of Miranda House, Delhi University, Delhi

Dr (Miss) Kusum Malhotra is a Research Associate in the Department of Botany, Delhi University

HOBBYISTS ! PROFESSIONALS !

We have over 100 fascinating electronic projects for you, all tested circuits by reputed designers.

Visha Electronics can supply components and printed circuit boards for a wide range of projects. Amplifiers . Sound and Light Effects . Doorbells . Games and Timers . Clocks . Instruments . Power Supplies and many more.

Send for a complete list of projects — FREE ! to Sole Selling Agents :

VISHA ELECTRONICS,
349, LAMINGTON ROAD,
BOMBAY-400 007.
TEL. : 362650.

Orders executed by V.P.P.

Manufacturers :
Electrographic Industries,
24-A, Sitladevi Industrial Estate,
140, Sitladevi Temple Road,
Mahim, Bombay-400 016.

VISHA ELECTRONICS
THE ONE-STOP COMPONENT SHOP

Clean fresh breath... Strong healthy teeth



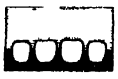
with **Colgate** Dental Cream

Brush your teeth with Colgate after every meal It protects you just the way dentists recommend all over the world

Bacteria grow in food particles left between your teeth These can cause bad odour and, later, painful decay

So always brush the Colgate way right after eating It s proven most effective to freshen your breath whiten your teeth, and fight decay

How Colgate's trusted formula works



Odour and decay causing bacteria grow in food particles trapped between your teeth



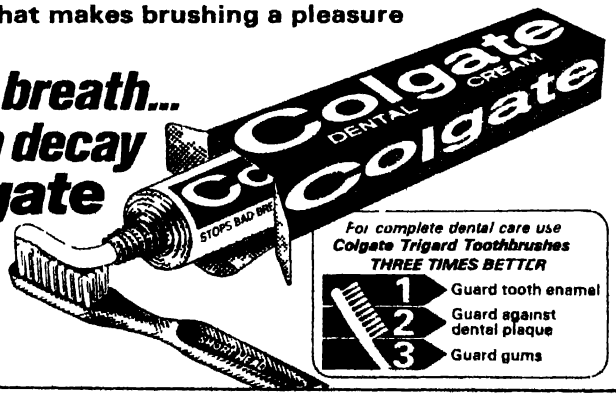
Colgate s unique active foam reaches deep to remove dangerous food particles and bacteria



The result attractive white teeth fresh breath confidence protection against decay

Colgate has the fresh, minty taste that makes brushing a pleasure

Stop bad breath... Fight tooth decay with Colgate Dental Cream



DC (73 8)

How much do you know about AEROBATICS?



Aerobatics is the art of performing unusual manoeuvres with a suitable aircraft A strenuous exercise for the pilot and the aircraft, it is not only a daring sport but also part of military pilots' training Listed below are 20 terms—pilots' jargon—along with their probable meanings Tick what you think is the correct meaning For the answers, please turn over to the next page

1. Aerobatic area: A Area near civil airport used for aerobatics B Altitudes considered safe for aerobatic exercises C Area away from towns and civil airports marked for aerobatics

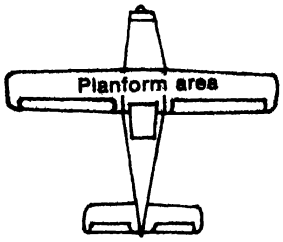
2 g load: A Measure of acceleration B Maximum load permissible in aerobatic aircraft C Minimum load recommended in aerobatic aircraft

3. Pitch. A Rotatory motion about the aircraft s normal axis B Rotatory motion about the aircraft s lateral axis C Flight in bumpy weather.

4. Loop: A Quick complete circle where the aircraft makes a 360 degree turn about its longitudinal axis B Complete circle in the pitching plane C Two complete circles in the vertical plane

5 Slow roll A A large diameter loop B Descending slowly in circles C A 360-degree turn along the fore aft axis

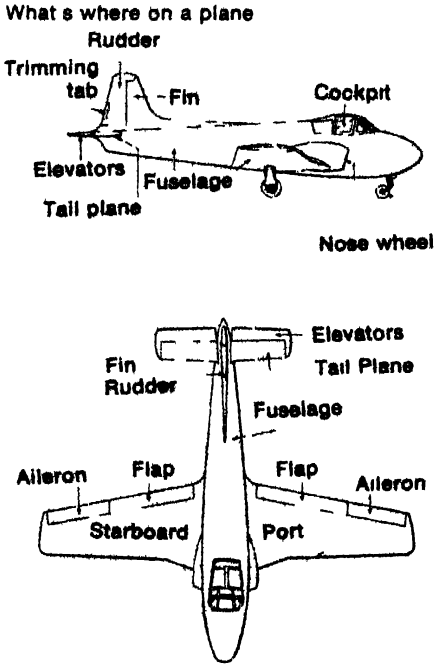
6 Wing loading: A Amount of fuel stored in the wings B Weight per unit wing planform area C Weight of the wings



7. Double bunt: A Inverted loop B Steep dive in rough weather C Changing direction twice in quick succession

8. Blackout: A Failure in radar communication B Fatigue due to supersonic speed C Loss of vision due to large positive g

9. Red out· A Mild blackout B Effect of negative g C. Warning lights signalling that the aircraft is running out of fuel



10. Stall: A Galley in an aerobatic plane mainly for keeping water and glucose B Nose dive C Loss of lift when the aircraft loses altitude rapidly

11. Spin: A A series of fast rolls B Steep spiral descent C Rotation about vertical axis (yawing) at the same altitude

12. High g cockpits: A Highly pressurised cockpits in aerobatic and military aircraft B Second cockpit in a tandem cockpit plane C Cockpits where seating arrangements of pilots is greatly inclined to the horizontal

13. Tail slide: A Backward movement of aircraft B Rudder C The wheel fitted under the tail to keep it off the ground.

14. Cuban 8: A Manoeuvre like a figure of 8 on its side B Manoeuvre resembling an upright figure of 8 C Double roll

15. Aileron turn A Fleeing from pursuing aircraft B Roll in a vertical dive C Outside loop

16. Stall turn: A Sudden tight turn through 90 degrees to shake off enemy B Steep climb followed by sudden drop and a 180 degree turn C Turning back immediately after take-off

17 Dog fight: A Combat manoeuvre where each participant tries to get behind and slightly above the other B Engaging a larger aircraft head on C Border patrolling aircraft which (during war) chase away enemy

18. Four leaf clover: A A good luck charm used by early aerobatic pilots B Aerobatic manoeuvre comprising of four loops at right angles C Special four-stroke engine used in aerobatic aircraft

19. Biplanes: A Twin-engine aircraft B Aircraft with two sets of planes (wings) C Two-seater aircraft

20. K factor: A Difficulty coefficient of aerobatic manoeuvres B Manoeuvrability of any aircraft C Manoeuvrability of aerobatic aircraft

Brain Teaser

Tailoring job

I got an export order for 480 shirts. I bought 12 sewing machines and appointed some expert tailors to do the job. However, many of them did not report for duty As a result, each of those who did had to stitch 112 shirts more than those originally planned by me with equal distribution of work How many tailors were appointed, and how many reported for work?

V. A. SHENAI

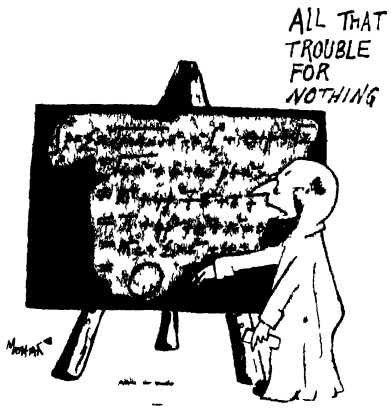
(Solution next month)

Solution to last month's Brain Teaser

Let e and y be the amounts received by the elder and the younger daughters, respectively

$$\text{Now } e^2 - y = 158$$
$$y^2 - e = 108$$

The minimum value of e is 13 ($13^2 = 169$, the next biggest number to 158), making y = 11. The minimum value of y is 11 ($11^2 = 121$, the next biggest number to 108), making e = 13. Hence, e = 13 and y = 11





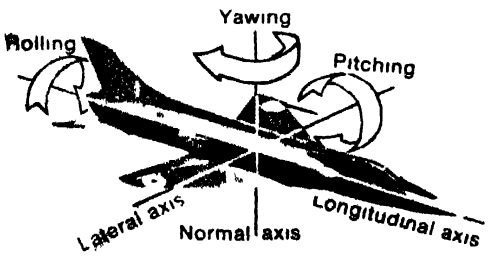
Answers:

1. Aerobatics area—C: Aerobatics practice should be performed away from towns and civil airport It is a general practice for flying schools (clubs) to designate a special aerobatic area for the purpose such that it does not interfere with civil aviation Also, the under-training pilot generally commences practices at an altitude of 1500 m or more so that the exercise can be completed not below 1000 m These altitudes allow sufficient margin for lack of skill in a light plane

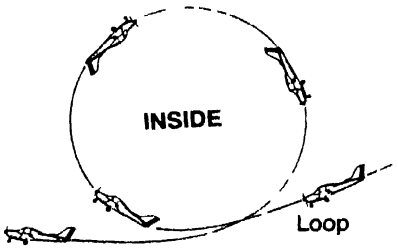
Sometimes aerobatics are demonstrated right in a city as during air shows but are carried out by skilled pilots and with prior permission so that precautionary steps can be taken The manoeuvres of an aerobatic aircraft will not be easy for civil pilots to anticipate if the exercises are carried out in civil aviation routes Generally, during air force aerobatics display civilian flights are suspended in that locality

2. g-load—A g-load is associated with forces arising out of accelerated flights When the aircraft is in steady level flight the lift produced by the air plane (wing) exactly balances the weight of the aircraft The aircraft is then said to be under 1g load condition When the aircraft falls freely the g-load is zero In certain manoeuvres it would be necessary to accelerate the aircraft from one altitude to another In order to accelerate upwards it is necessary to produce lift not only to overcome weight but also to achieve the necessary acceleration The ratio of this total lift on the aircraft to its weight is called the g-load of the aircraft In inverted flight the negative lift produced may even exceed the weight when the aircraft would accelerate downwards at a value exceeding 9 81 metres per sec in which case a negative g would result

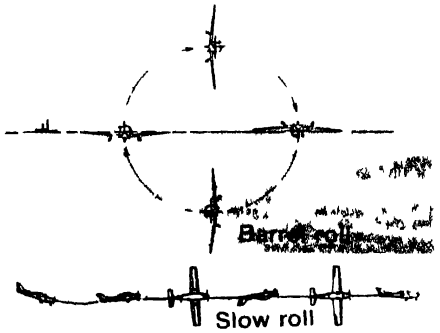
3 Pitch—B A flight vehicle has freedom of movement about three axes—longitudinal lateral and normal (or vertical in the rigging position axis) Rotatory motion about the longitudinal axis is called rolling about the normal axis yawing and about the lateral axis pitching



4. Loop—B: A loop is perhaps the simplest aerobatic manoeuvre For this the aircraft starts with a high speed (25 to 30 per cent above cruising speed) and climbs steeply The speed decreases while climbing but once over the top the speed begins to increase and the pilot has to reduce it Easing the aircraft out of the dive completes the loop In a loop the pilot is always on the inside (see fig)



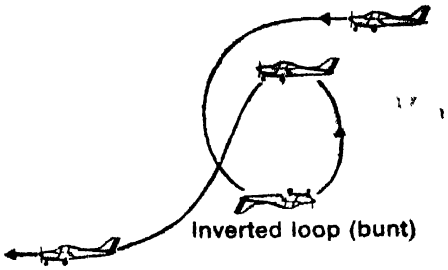
5. Slow roll—C The 360 degree slow turn along the longitudinal axis is more difficult than a brisk roll Control of the aircraft while inverted is perhaps the most difficult part of the manoeuvre This manoeuvre calls for more handling skill than a loop and is difficult to accomplish with a slow, light aircraft Here again as in a loop exercise an increase in speed is desirable at the start since most engines stop firing in inverted flight and sufficient momentum is necessary to carry it through the thrustless section of the manoeuvre without much loss of height



6. Wing loading—B: This is one of the most important parameters in aerodynamic design The weight of the aircraft compared to the wing area determines its take-off and landing speeds which in turn determines the length of the runway high take-off speeds need shorter runways Lower wing loadings contribute to manoeuvrability. Aerobatic aircraft have a low wing-loading

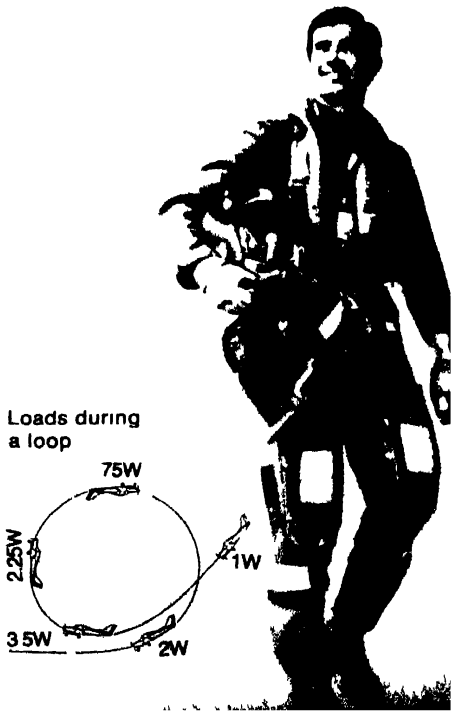
7. Double bunt—A: In this aerobatic manoeuvre the pilot is on the outside of the curved path A manoeuvre that took long to be successfully accomplished, this imposes severe strain on the aircraft and on the pilot Several pilots who later tried to attempt it lost their lives

In the normal loops the climb to the top is completed while there is speed and power in hand, whereas in the inverted (or outside) loop the climb to the top has to be undertaken when the engine and aerofoils are in the inefficient, inverted positions Also few aircraft are designed to withstand heavy inverted loads structural damage and failure are more likely to occur under such conditions



8 Blackout—C The average pilot usually blacks out after four seconds at (high) 4 g At this g load when his body feels four times as heavy as normal his head feels heavy on his neck and the heart finds it difficult to pump the heavy blood to the head The insufficient blood flow to the head lessens vision The pilot does not become unconscious though he cannot see A trained pilot recovers as soon as normal or more tolerable g is achieved and he regains his normal sight Loads greater than 7 g or 8 g cause serious physical injury

Aircraft of aerobatic category can withstand loads of the order of 10 g



To delay the effects of blackout, pilots of high performance fighters wear what is known as *G* suit or anti-*G* suit The suit covers the fleshy parts of the legs and abdomen so that when g force increases, air pressure at a proportional rate is fed into the suit This delays the tendency of the blood to accumulate in the lower parts of the body

9. Red out—B: Red out occurs at negative g A pilot's tolerance for negative g is numerically less In negative g which occurs during inverted flight or during bunting, the blood rushes to the head This causes the pilot to literally see red The blood could rush in even at a small negative load, causing the pilot to lose control of the aircraft This is especially dangerous if the engines are not designed to fire at negative g conditions, the aircraft could easily get involved in a fatal accident

10. Stall—C: A stall is due to loss of lift Beyond a certain attitude (angular relation between aircraft's axis and wind direction) there is a sudden drop in the lift produced by the wing and the aircraft rapidly loses height For each aircraft there is what is known as the stalling speed below which it cannot fly level The minimum take off speed is normally 1 2 times the stalling speed which again depends on the wing loading

11. Spin—B: In a spin the wings are generally stalled that is they do not provide enough lift The aircraft begins a steep spiral descent This occurs if one wing stalls more violently than the other The attitude of the aircraft may vary from near horizontal to almost vertical. A spin is not a pleasant aerobatic manoeuvre, nor is it a useful combat manoeuvre, but since it can occur accidentally—especially during a fight—pilots are trained to get out of it

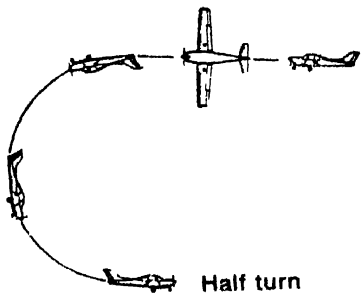
12. High g cockpits—C: To withstand high g loads, a position close to the horizontal serves best for the pilot Crouching and hunching while bracing in the stomach muscles helps Modern fighter aircraft are equipped with what are called high-g cockpits where the seating arrangement for the pilot is such that his back is inclined at nearly 30 degree to the horizontal

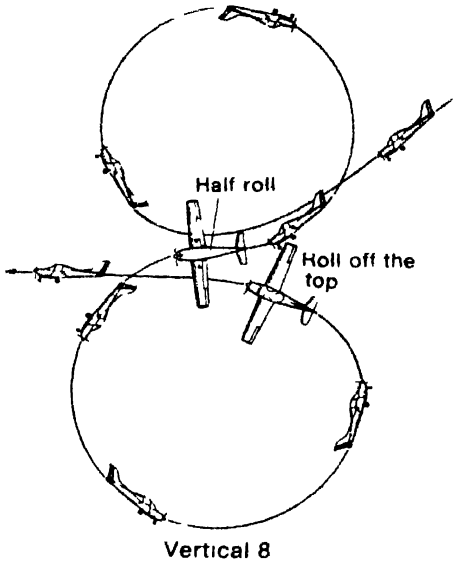
13. Tail slide—A: One of the rarest of all manoeuvres it occurs following a stall with nose very high It can also be induced



by flying upwards vertically until the aircraft stops and slides backwards In aircraft with high stalling speeds accidental tail sliding is unusual

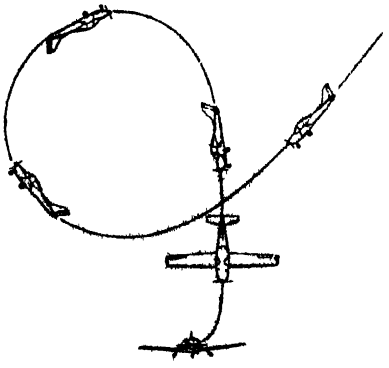
14. Cuban 8—A. This horizontal figure of eight comprises of two loops and two descending rolls. This manoeuvre can be repeated without any loss of height The continuous half roll is also a horizontal 'eight", but the method employed is different (see figures) Here again there is no loss of height

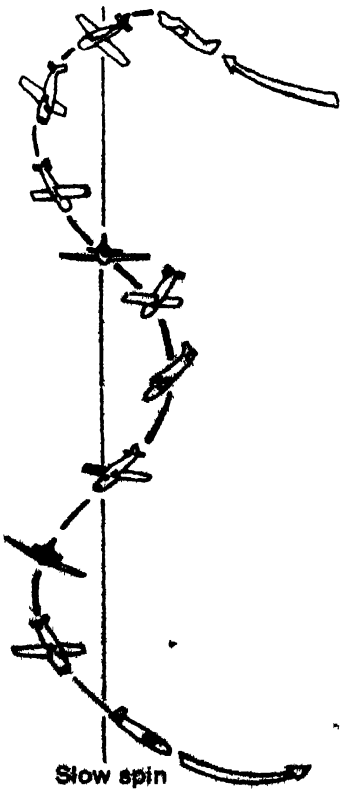


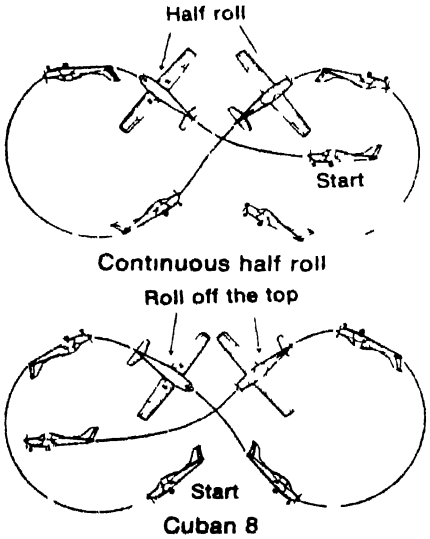


The vertical eight combines a loop a half-roll and a roll-off-the-top in a continuous sequence The start and finish points are at the middle of the eight and therefore suitable height to accommodate the lower sequence should be allowed

15. Aileron turn—B· This manoeuvre is used to pull out at a different heading than that at the start The new heading will depend on the number of degrees of the

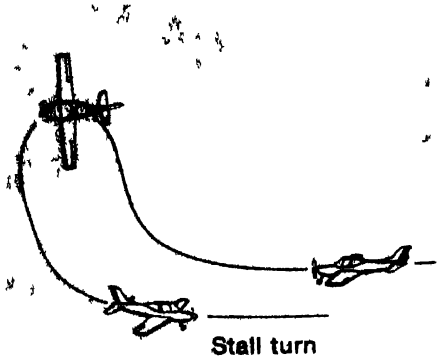






roll during the dive Usually a 180-degree turn is associated with the aileron turn

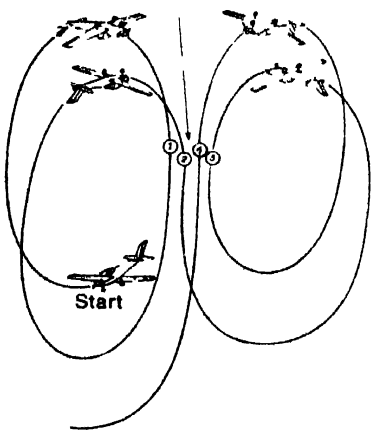
16. Stall turn—B: A combat manoeuvre which originated during World War I, it involves changing the aircraft's direction through 180 degrees to shake off the enemy aircraft The aircraft climbs up in a near-vertical attitude and is then made to yaw either to the left or right (by apply-



ing the rudder) This continues till the aircraft is in an almost vertical dive Subsequent pull-out brings the aeroplane in level flight but with a reciprocal heading

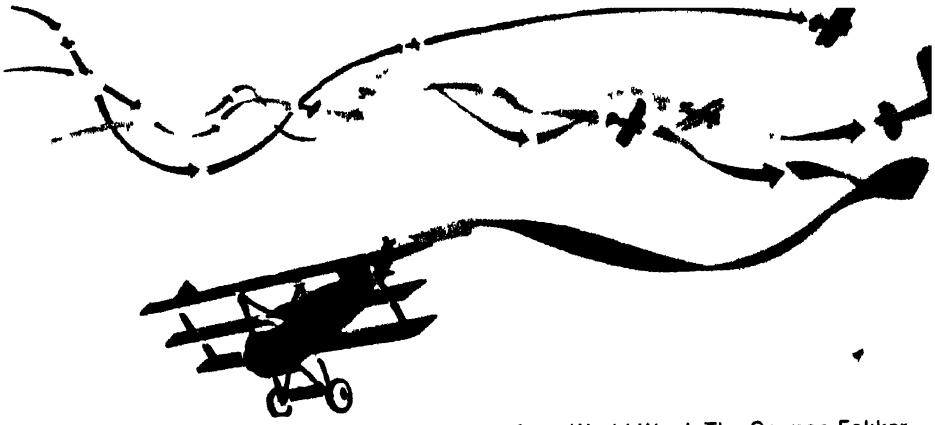
17. Dog fight—A: In a dog fight each pilot tries to get his aircraft into the strategic position which is behind and slightly higher than the enemy by suitable aerobatic manoeuvres Heat seeking missiles that he fires from this position home in directly on the heat source—jet exhausts—of the aeroplane in front The whole idea in a dog fight is to prevent the enemy from escaping and to capture him, or failing this to destroy him

18 Four leaf clover—B: A combination of four loops and four aileron turns it begins with a normal loop which continues over the top until the aircraft is in a steep dive



when an aileron turn of 90° makes it ready for the next loop At the end of the manoeuvre the aircraft is on its original heading

19. Biplanes—B: Biplanes have two sets of planes (supporting structures), commonly known as wings, one above and the other below with a slight stagger The first ever



The chase Reconstruction of a dog-fight scene from World War I The German Fokker triplane piolated by Baron Manfred von Richthofen (blue) dives after the fleeing British Sopwith Camels (grey) piloted by novice Wilfred May May had to land because of his jammed guns Seeing May's peril RAF squadron leader A R Roy Brown (black) rushes to his aid and getting almost directly overhead fired at the German disabling him Brown then dropped out of the chase But Richthofen was apparently not wounded he continued to gain on May who could not shake him off despite many manoeuvres Meanwhile they flew over Australian riflemen machine gunners and anti aircraft batteries who fired at the German breaking off parts from the triplane which then swerved and crashed It was found later that Richthofen had been killed by a single bullet

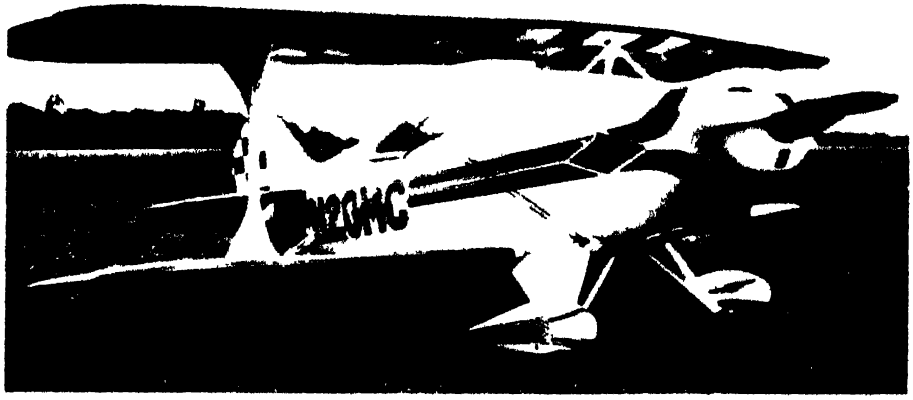
manned flight was with a biplane —the Wright brothers *Kittyhawk* Biplanes were more compact than the old monoplanes the weight being concentrated near the centre of gravity Biplanes have low wing-loading which is good for manoeuvrability and its compactness coupled with great rigidity which prevents dangerous distortions during flight exercises This made them a very popular choice for a light aerobatic aircraft However modern high speed monoplanes with higher wing loading are also quite manoeuvrable and aerobatically good

20. K factor—A Each aerobatic manoeuvre has a difficulty coefficient known as K factor which is used for judging the performance of pilots in competitions The method was devised by Jose L Aresti an outstanding Spanish aerobatic pilot The individual score for each manoeuvre (given from 1 to 10) is multiplied by the K factor

Though originally performed mostly by stunt pilots and military pilots aerobatics has now caught the fancy of sportsmen Several flying clubs in the US offer courses in aerobatics An international competition supervised by the Federation Aeronautique Internationale (FAI) is held every two years The FAI also publishes a list of stunts recognised at international contests Competitions are at three levels primary advanced and unlimited

M M SIVARAMAKRISHNAN

Dr Sivaramakrishnan is Assistant Professor Department of Aeronautical Engineering Indian Institute of Technology Bombay

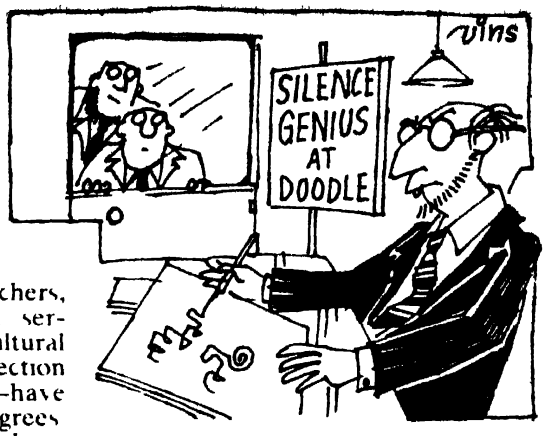


A two-seater biplane The Pitts S-2A Special is certified for aerobatic and normal categories Its ailerons on both upper and lower wings are aerodynamically balanced for high rate of rolls at low speeds and even full vertical rolls can be made with ease The wings have no flaps or tabs The different wing sections make inverted flight performance equal to conventional flight and also facilitates inverted loops—one of the most dangerous manoeuvres in aerobatics

Geometry and the modern student

Dan Pedoe

If the pleasurable art of geometry is well-taught, even students may discover new theorems



DO YOU doodle when you are sitting listening to a talk—a social captive at a lecture or a committee meeting? If you do, are the curves you draw random paths, with no meaning to yourself or even to a psychiatrist, or do you draw precise geometrical patterns? Do you sketch sets of circles which touch each other in various ways, and discover new theorems not discovered by Euclid or his successors over the past 2,000 years? Do you, in your spare time, use ruler and compass to verify, by accurate drawing, the theorems you have guessed at by rough sketches? And after verification, as you think do you indulge in the final luxury, the mathematical proof of your intuition?

If you follow this sequence, you are following the pattern of intellectual activity indulged in by many happy people all over the world. A good ruler and compass are not too easy to obtain even in the so-called advanced countries but if you live outside these countries you are almost certain to have used a compass at some time or other. In the countries which experienced the doubtful benefit of the *new math* at an early stage after the Russians launched Sputnik, there are many students who have passed through high school without being exposed to mathematics at all, and certainly not to geometry.

Geometry neglected is imagination deprived

It is a sad fact that the advanced countries have many mathematicians in high positions who dislike geometry. This has resulted in geometry being thrown out of many curricula. One reason may well be that very few mathematicians are equally good at all branches of mathematics. If we happen to find a particular branch of mathematics difficult, it is perhaps natural to dislike it, but it is certainly unethical to prevent others from learning and perhaps enjoying it.

Some years ago a great educational experiment, called the Open University, began in Britain. People without university degrees and from all walks of life were eligible to study for an open university degree by watching lectures on television, working through correspondence courses, and attending local and national seminars. Thousands of clerks, secretaries, primary school teachers, housewives, lower-grade civil servants, manual workers, agricultural labourers—a complete cross-section of the British population—have obtained open university degrees. And quite a number of them have done so in mathematics. But the first year course in mathematics, the foundation course, contained no geometry at all and there was very little as the course developed. The emphasis right from the beginning, was on *abstract reasoning*.

There have always been mathematicians who have boasted that their work contained no diagrams. It is true that diagrams can sometimes mislead us. But does the blessed faculty of sight always mislead us? Of course not! It is known that many great mathematicians and scientists are helped enormously in their discoveries by their visual conceptions. Why deprive a large part of humanity of the pleasure of contemplation and the creation of theories or theorems?

The pleasures of geometry

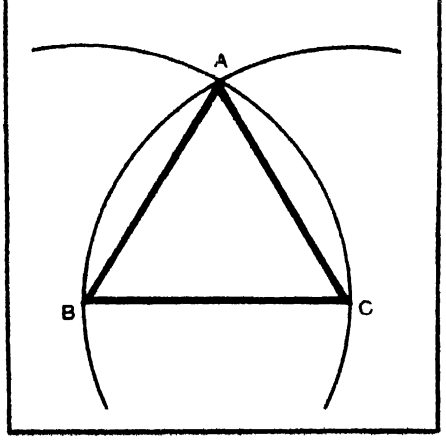
The courageous reader can find much, I think, to give visual and intellectual pleasure in my book *Geometry and the Liberal Arts*. In this book, together with many other matters, I discuss the pleasure taken by the great Renaissance artists in the art of geometry. Enthusiasm for geometry was common all through the Renaissance. The healing effects on the spirit induced by the contemplation of geometrical diagrams were known to many scholars and saints at all periods of recorded history.

Art and geometry are very close neighbours and mathematical embroidery was introduced into British primary schools in Victorian days to relieve the oppression of poverty and to bring some beauty into the lives of poor children.

Modern American students when they first come across geometry, are often ecstatic, develop great enthusiasm and rapidly make up for the lean high school years when they were not offered geometry courses in social behaviour (how to order dinner in a restaurant), car driving, sex education and so on take the precedence.

Students sometimes discover new theorems, unknown even to Euclid and his successors and I shall describe a theorem which will be associated with the name of a student Kevin Panzer, as long as libraries survive.

Fig 1



A simple construction

As a preliminary I must mention Euclid's construction for an equilateral triangle (a triangle with all its sides equal in length) on a given base BC, the instruments available being ruler and compass. Fig 1 shows the simple construction. With compass centre at B, radius BC, draw a circle. With compass centre at C, radius CB, draw a second circle. Let A be one of the two intersections of these two circles. Then BA = BC, radius of first circle, and CA = CB, radius of the second circle, and since BC = CB, we have BC = BA = AC, and so the sides of the triangle ABC are equal to each other.

This is simple, but not trivial reasoning, and is stressed because it is one of the beginning exercises in geometrical proof. I would also mention the imperfections in the proof, since there are unspoken hypotheses, a serious one being that our two constructed circles do, indeed, intersect, but we shall not discuss these matters here.

The fixed compass can serve as well

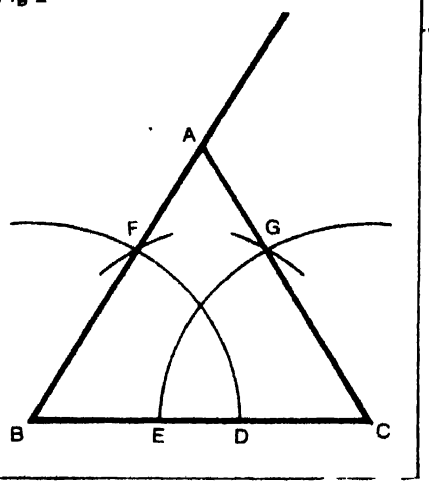
In periods of geometrical activity subsequent to Euclid, geometricians have discussed variations of the Euclidean tools, the unmarked ruler and the compass, this being a compass with an adjustable radius. One of the variations discussed early on, in the 10th century, by Abû 'l Wefâ was the restriction of geometrical tools to an unmarked ruler and a *rusty* compass, one with a *fixed* opening which cannot be changed (for fuller details, see "The Geometry of the Fixed Compass" by Arthur E. Hallerberg, *Mathematics Teacher* of April 1959, **52**, 230).

Abû 'l Wefâ was able to show that all constructions possible with Euclidean tools could also be achieved with an unmarked ruler and a rusty compass, not, of course, as easily, but that is not the point. The question I put to my students was based on the above Euclidean construction: to erect an equilateral triangle ABC on a given base BC, using only an unmarked ruler and a *rusty* compass.

I expected something like Fig. 2. Draw circles with centres at B and C respectively, meeting BC in D and E respectively. Mark off DF=BD BF on the first circle, and EG CE=CG on the second circle, using the compass, so that triangles BDF and CEF are both equilateral, and (angle FBD) =(angle GCE) =60°.

Joining B to F, and C to G will give A, the third vertex of the desired equilateral triangle, since if each of two angles of a triangle is 60°, the triangle must be equilateral.

Fig 2

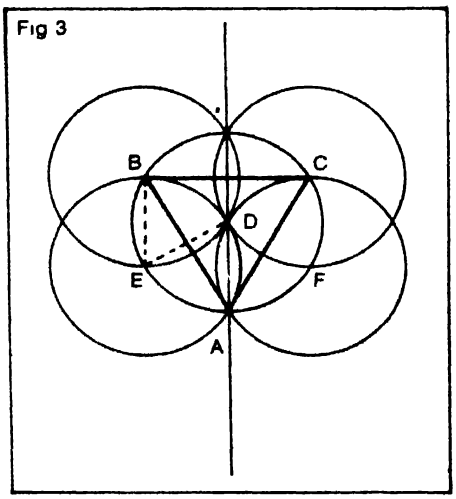


Never underrate students!

What I received from Kevin Panzer, with no word of explanation, was Fig. 3. I had never seen this construction, involving five equal circles, before, and it looked too obvious to be correct! Given a rusty compass with radius $\geq$ BC/2 (to ensure that the circles with centres at B and C intersect), the five circles in the diagram are forced on the attention of anyone doodling with a rusty compass. The circles with centre at B and C intersect at two points, one being D. The circle with centre at D passes through B and C, and gives us the points E and F. The circles with centres at E and F pass through D and give us the point A.

Is A the third vertex of an equilateral triangle ABC? I did the drawing a number of times, and it seemed to work, even with a radius for the rusty compass equal to BC/2, the minimum for obtaining a point D. I then tried to prove the accuracy of the construction. Short, gem-like proofs do not often tumble out of the air! My first proof used analytical geometry which, as I was educated in a pre-Sputnik era, I knew something about, and this proof covered several pages. But I knew the construction was correct!

Fig 3



An editor of Newton's mathematical papers, with an enormous knowledge of geometry (since Newton wrote his great *Principia Mathematica* entirely in geometry) then confirmed that the construction was new to him, and suggested a proof using angles. Suddenly I saw the one-line proof, which will be given at the end of this article. Before you turn to the end, try to prove the accuracy of the construction yourself.

The proof I discovered is so short that both construction and proof were initially rejected by the editor of a mathematics magazine as being trivial and obvious! He relented after I insisted on the novelty of the construction, and told him that nothing like it could be found in a Russian book on constructions with a rusty compass. He had referred me to this book, being certain that the Russians must have come across this construction.

It is true that a lot of geometry is still taught in Russian high schools and universities, and *Geometry and the Liberal Arts* has been translated into Russian, which is a sign of their interest in geometrical culture. Recently, a great breakthrough in computer programming was achieved by a Russian graduate student who happened to know some geometry, so the study of geometry in Russia has paid off, and this startling success may well influence those who control curricula in other countries.

To return to Kevin Panzer (he admits that he did the minimum amount of work possible on the rusty compass construction), he had no idea whether it always worked, and was surprised that I was interested. I must take some credit for not rejecting the construction out of hand (never underrate students!), and to be just to myself as well, the construction should be known as the Panzer-Pedoe construction!

Here is the proof I promised you! If we can prove that angle BAD 30°, then since AD is an axis of symmetry for triangle BAC, triangle ABC is equilateral. Now triangle BDF is clearly equilateral, so angle BED 60° The circle with centre at E passes through B, D and A, so that angle BAD ½(angle BED) 30°, since the angle subtended by the chord BD at F, the centre of the circle BDA, is twice the angle subtended at a point on the circumference. Q.E.D!

Dr Dan Pedoe is Professor at the School of Mathematics, University of Minnesota, USA He received his Ph D from Cambridge University, UK He has earlier taught for several years at the University of London, UK, and the University of Khartoum, Sudan Dr. Pedoe has written a number of books about mathematics and, especially, geometry In 1968, he received the Lester R Ford award of the Mathematical Association of America for his expository writings Along with Sir William Hodge, he is co-author of *The Classical Methods of Algebraic Geometry (3 Volumes)*.

Recommends reading **1** Dan Pedoe, *Geometry and the Liberal Arts*, Penguin, 1976; **2.** Arthur Hallerburg, "The Geometry of the Fixed Compass", *Mathematics Teacher*, **52**, 230, **3.** D Pedoe, Geometry and the Pleasure Principle", *The Mathematics Teacher*, (India), **11A**, 147, **4.** D Pedoe, *The Gentle Art of Mathematics*, Dover Publications, New York, 1978, **5.** D Pedoe, *A Course of Geometry for Colleges and Universities*, Cambridge Univ Press, 1970, **6.** D Pedoe, *Circles A Mathematical View*, Dover, 1979. **7.** *Crux Mathematicorum*, Ed. Léo Sauvé, 281, Echo Drive, Ottawa, Canada KIS IN3.

Low fuel level indicator/alarm

THIS is a fully solid-state device that provides a light signal as well as an audio alarm when the fuel level in a car's tank falls below the pre-set low level. This device can be used on all cars having a 12-volt battery system and a fuel gauge operated by a float-driven potentiometer such that the voltage developed across the potentiometer is proportional to the fuel level in the tank. This is the electrical fuel level measuring system used in the majority of the cars.

To check whether your car has a similar system you have simply to measure the voltage between the car chassis and the potentiometer terminal provided on the fuel tank. If the voltage reading is approximately proportional to the fuel level then the device can be installed in the car. Normally the reading of the voltmeter when the tank is empty, will be a fraction of a volt and when the tank is full, 6 to 8 volts. The polarity of the above voltages will of course depend upon the positive and negative ground system of the car. Two different but similar circuits are shown here for the two ground systems (Figs. 1 and 2).

With either positive or negative ground system the input for the device—necessary to sense the fuel level—is obtained across the float-driven potentiometer terminal on the fuel tank and the chassis of the car. The integrating circuit consisting of 10K+10K resistors and 100 mfd capacitor provides the mean or average value of the float potentiometer output. This is necessary for when the car accelerates decelerates takes a turn or is moving on a slope abrupt changes in the level of fuel and thus the float controlling the potentiometer, are caused. This voltage is fed to the input of the Schmitt trigger. When the tank is full, the fuel potentiometer provides sufficient output to drive the first transistor Tr1 of the Schmitt trigger in saturation. This keeps the second transistor Tr2 off. As the input of the Darlington pair consisting of Tr3 and Tr4 is connected across the collector-resistor of Tr2 this also results in its remaining off. As the fuel level drops, the voltage across the float-driven potentiometer also falls. When the voltage falls below 1.5V, it cannot keep the transistor Tr1 in saturation. The regenerative Schmitt trigger action occurs and transistor Tr1 and Tr2 change their states. Thus Tr1 becomes off and Tr2 saturated. This also drives the Darlington pair in saturation which in turn drives the lamp and the audio oscillator to provide the audio-visual alarm.

The 250 mfd capacitor in the input circuit of the Darlington pair is for making the indication as well as the alarm system inoperative for the first few seconds when the car is started. This provides sufficient time for the 100 mfd capacitor in the integrating circuit to charge to the mean level of fuel and initial false low level signal provided by the 100 mfd capacitor while it charges to 1.5V or more.

The diagrams of the audio oscillator circuit and float driven potentiometer fuel-level measuring system normally found in cars are also given here (Figs. 3 and 4). The audio oscillator has to be connected across the lamp such that it receives the correct supply polarities with either positive or negative ground system. An on/off switch is also provided in series with the audio oscillator so that though the lamp remains lighted the audio alarm can be

FIG 1 FOR 12 VOLT NEGATIVE GROUND SYSTEM

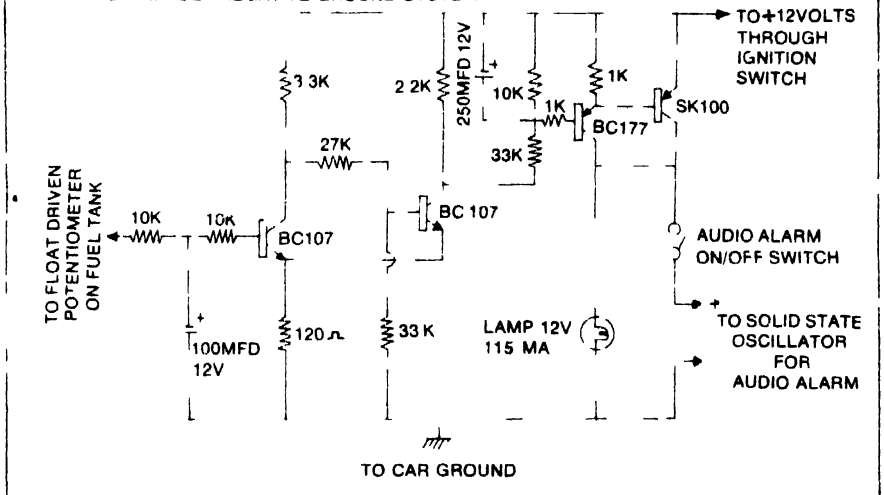


FIG 2 FOR 12 VOLT POSITIVE GROUND SYSTEM

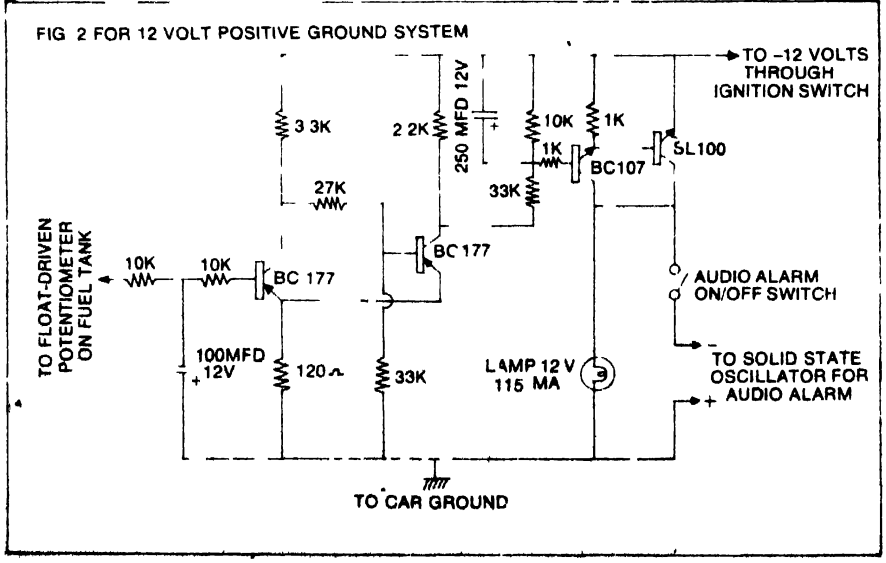
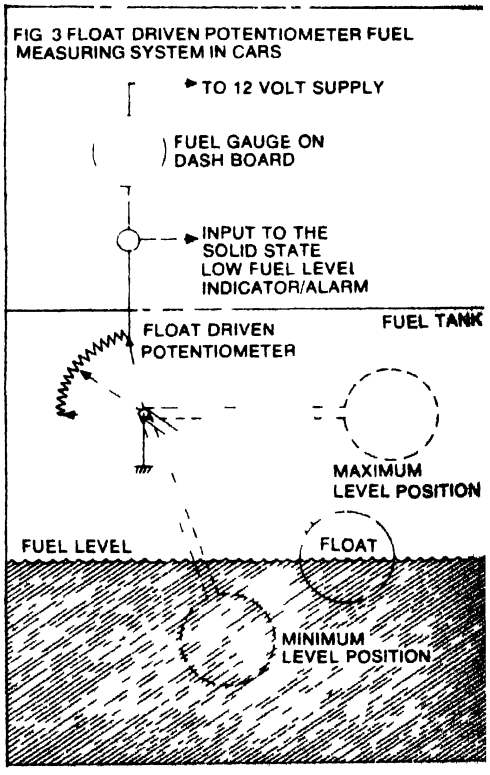


FIG 3 FLOAT DRIVEN POTENTIOMETER FUEL MEASURING SYSTEM IN CARS



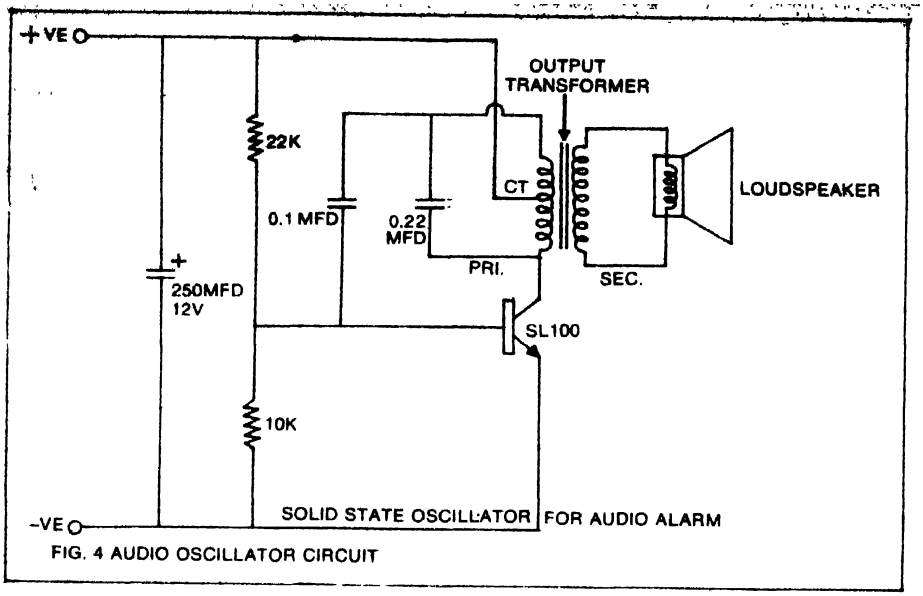


FIG. 4 AUDIO OSCILLATOR CIRCUIT

switched off once the driver is aware of the low fuel level.

You will need :

Transistors. For negative ground system : BC107 - 2 nos.; BC177 - 1 no.; SK100 - 1 no.; and SL100 - 1 no.

For positive ground system : BC177 - 2 nos.; BC107 - 1 no.; and SL100 - 2 nos.

Capacitors. Electrolytic : 100 mfd - 12 V - 1 no, 250 mfd - 12 V - 2 nos.

Ceramic or polyester: 0.22 mfd - 1 no.; and 0.1 mfd - 1 no.

Resistors (all ½ watt) : 33 K - 2 nos., 27 K 1 no., 22 K - 1 no.; 10 K - 4 nos.; 3.3 K - 1 no., 2.2 K - 1 no.; 1 K - 2 Nos.; and 120 ohms - 1 no.

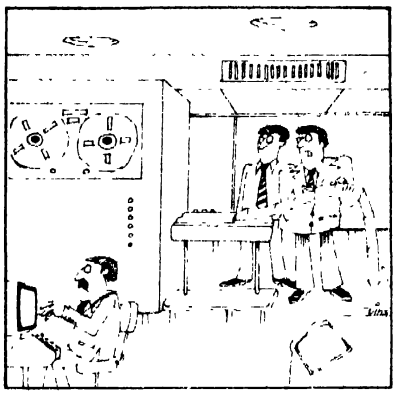
Output transformer (Push pull) : Primary matching with transistor SL100. Secondary matching with loudspeaker used - 1 no.

Loudspeaker : Miniature 8 ohms, 200 mW 1 no.

Approximate cost of the above electronic components in the Bombay market, Rs. 55.

Misc. : 12 volt 115 mA lamp with holder., wires, screws, suitable enclosure, on/off switch, veroboard or group board, solder, etc.

ANIL V. BORKAR



"Because of its country of origin, every time we ask it to give a new dress design, all it can come up with is 'jeans and T-shirts.'"



Only Leyparts for Ashok Leyland vehicles

Your Ashok Leyland vehicle by now, you've discovered it's really a prized possession. But are you looking after it the way you're supposed to?

For instance, when you replace parts, do you go in for genuine Ashok Leyland spares: Leyparts? Or just settle for cheaper spares?

Leyparts: tailor-made for Ashok Leyland vehicles

When you buy replacement parts, it makes good sense to match them to the originals. That way, you can be sure of correctly-machined, precision-engineered parts that give you real good mileage for your money. And that's where Leyparts come in.

Every one of the 12,000 plus Leyparts represents the same engineering excellence of Ashok Leyland that goes into their vehicles.

For instance, sophisticated instruments like spectrograph and pneumatic gauges are used to ensure correct metallurgy and accurate dimension. The continuous gas carburising process ensures uniformity in hardness and strength as well as excellent metallurgical control to reduce wear and tear. And so it goes on.

What's more, Leyparts represent the very latest in Ashok Leyland's R & D, making them the most advanced-designed spares going in the country.

In short, Leyparts are care-crafted exclusively for Ashok Leyland vehicles – for optimum efficiency and ultimate economy. From now on, don't risk expensive premature failure from ordinary spares. Get the dependable quality of Leyparts – available in components and kit forms – from our authorised dealers throughout the country.

Ashok Leyland Limited
Ennore Madras 600 057

The original spares for Ashok Leyland vehicles:

Leyparts



SAA/ALI/83

CSIR society is reconstituted

THE SOCIETY of Council of Scientific and Industrial Research has been reconstituted with effect from 6 June 1980 for a period of two years, and consists of the following persons:

President: Prime Minister; *Vice President:* Prof. S. Nural Hasan.

Members: Mr. Vasant Sathe, Minister for Information and Broadcasting; Mr. N. D. Tiwari, Minister for Planning and Deputy Chairman, Planning Commission; Dr Charanjit Chanana, Minister of State for Industry; Prof. Satish Chandra, Chairman, University Grants Commission; Dr C S. Jha, Educational Adviser (Technical), Ministry of Education; Dr O P Gautam, Director General, Indian Council of Agricultural Research, Dr V. Ramalingaswamy, Director General, Indian Council of Medical Research, Dr Abad Ahmed, Professor, Delhi School of Management and Director, South Delhi University Campus, Mr K C Khanna, Chairman-cum-Managing Director, Kudremukh Iron Ore Ltd, Bangalore, Mr J.R.D. Tata, Chairman, Tata Industries Ltd, Bombay; Dr. Raja Ramanna, Secretary, Department of Defence Research & Development, Ministry of Defence, Dr R N. Dogra, Kothi No. 4, Sector 5, Chandigarh, Dr Yash Pal, Director, Space Applications Centre, Ahmedabad, Dr. C.N R. Rao, Indian Institute of Science, Bangalore; Dr. Gurbaksh Singh, Vice Chancellor, Delhi University.

The following members of the Governing Body of CSIR shall be members of the CSIR society:

Director General, Scientific & Industrial Research, New Delhi (Chairman, Governing Body); Nominee of Ministry of Finance, Government of India (Mr. G. Ramachandran, Finance Secretary); Dr. S. Varadarajan, Chairman-cum-Managing Director, Indian Petro-Chemicals Corporation Ltd, Baroda, Dr. B. Ramachandra Rao, Vice Chairman, University Grants Commission, New Delhi; Prof. A. K. Sharma, Calcutta University.

The following persons will be Chairmen of the Coordination Councils:

Chemical Sciences Group. Dr. H.V.K Udupa, Director, Central Electrochemical Research Institute, Karaikudi (up to 30 Sep. 1980).

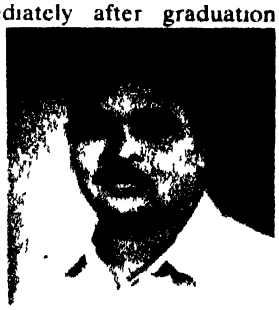
Physical and Earth Sciences Group: Dr. S. Z. Qasim, Director, National Institute of Oceanography, Goa (up to 12 May 1982).

Engineering Sciences Group: Mr K. D Sharma, Director, Central Glass & Ceramic Research Institute, Calcutta (up to 31 July 1980), Dr. V A. Altekar, Director, National Metallurgical Laboratory, Jamshedpur (from 1 Aug. 1980)

Biological Sciences Group: Dr. Nitya Nand, Director, Central Drug Research Institute, Lucknow (up to 17 Jan. 1981).

Patil is deputy minister for science

THE PRIME Minister recently appointed a Deputy Minister for Science & Technology and Space The man appointed is Mr. Vijay N Patil, an agricultural science graduate and lawyer. Mr. Patil has an M Sc degree in agriculture from the Indian Agricultural Research Institute (INRI). New Delhi; he served as a lecturer immediately after graduation from the IARI



Vijay N Patil

Atomic Energy Commission —governing body

THE FOLLOWING are members of the Governing Body of the Atomic Energy Commission:

Chairman (ex-officio): Mr. H. N. Sethna. Secretary to the Government of India Department of Atomic Energy, Member for Finance and ex-officio Secretary to the Government of India in the Department of Atomic Energy in financial matters: Mr. R N. Malhotra, Secretary to the Government of India Department of Economic Affairs, Ministry of Finance; Member for Research & Development (the incumbent to be selected will be Director, Bhabha Atomic Research Centre, Bombay), Rao Sahib C. R. Krishnaswamy, Secretary to the Prime Minister; and Mr. D V Kapur, Secretary to the Government of India Department of Power, Ministry of Energy.

Department of Space

THE FOLLOWING are members of the Governing Body of the Department of Space:

Chairman: Dr. S. Dhawan, Secretary to the Government of India Department of Space; Member for Finance: Mr. R. N. Malhotra, Secretary to the Government of India Department of Economic Affairs, Ministry of Finance; Dr. Brahm Prakash, Research & Development; Dr. M.G.K. Menon, Secretary to the Government of India Department of Science & Technology; and Rao Sahib C. R. Krishnaswamy, Secretary to the Prime Minister.

Departments of Atomic Energy, Space, Electronics and S&T

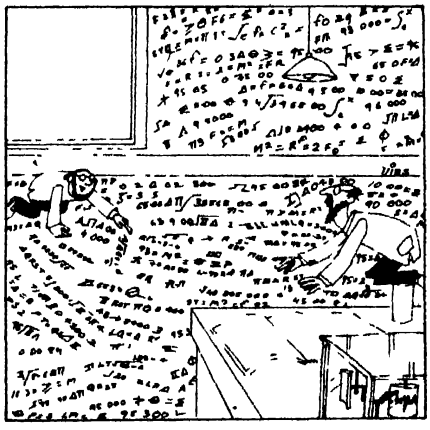
THE FOLLOWING have been nominated member of the Parliamentary Consultative Committee for the departments of Atomic Energy, Space, Electronics, and Science & Technology:

Chairman: Mrs. Indira Gandhi, Prime Minister; Mr. C.P.N. Singh, Minister of State for Defence and departments under the charge of the Prime Minister; Mr. Sitaram Kesri, Minister of State for Parliamentary Affairs—ex-officio member; Mr. P Venkatasubbiah, Minister of State for Parliamentary Affairs and Home Affairs—ex-officio member; Mr. Vijay N. Patil Deputy Minister for the departments of Science & Technology and Space.

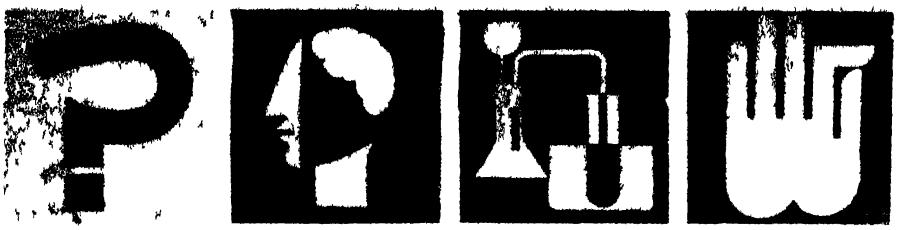
The other members are, *Lok Sabha:* Mr. P V G. Raju, Dr. M. S. Sanjeevi Rao, Mr. Digvijay Singh, Mr. E. Balanandan, Mrs. Gurbinder Kaur Brar, Mr. Nihal Singh Jain, Mrs. Sheila Kaul, Mr. Ajit Pratap Singh, and Mr. Hari Krishan Shastri; *Rajya Sabha* Mr. S. K. Vaishampayan, and Mr. K. C. Pant.

International Council for Reprography

Mr. K. S. Nagarajan, officer-in-charge, INSDOC Regional Centre, Bangalore, has been elected the first Vice President of the International Council for Reprography (ICR) As Vice President, Mr. Nagarajan's responsibilities will include the examination of the UNESCO's programme of work as it relates to reprography.



"You're lucky, professor, I've found the beginning."



The method of science

9

Text © P M Bhargava
Design Feroze Chandra

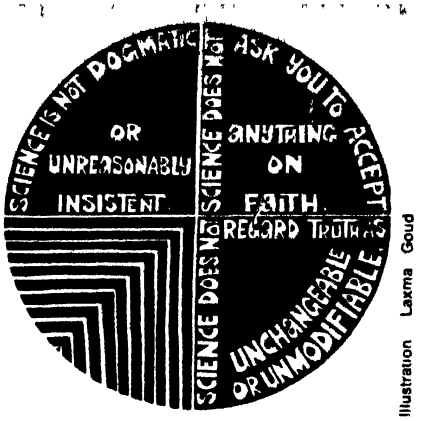


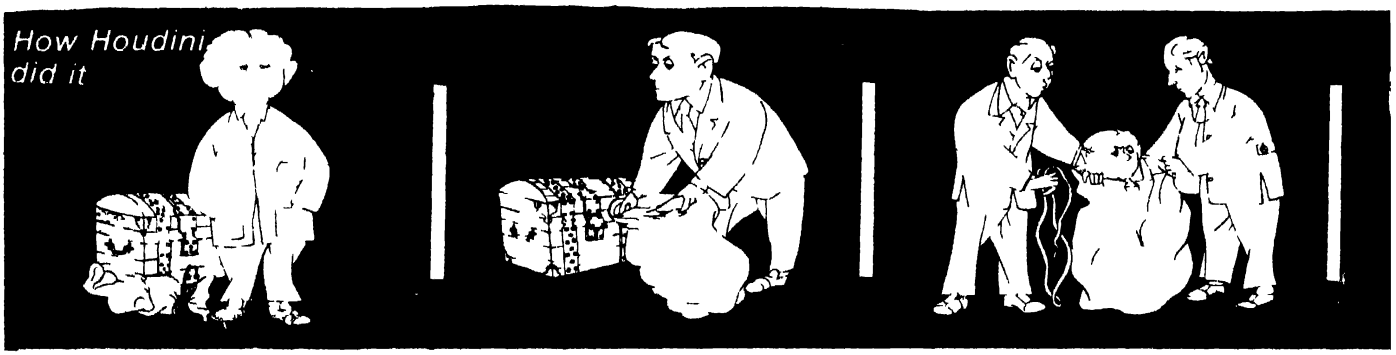
Illustration Laxma Goud

Science versus the s

One often witnesses or hears about events which in the opinion of many people can have only a supernatural explanation—that is an explanation outside the scope of the method of science In reality all such events do have a scientific explanation often simple and ingenious!

For example Houdini the famous magician could swim ashore safely after he had been tied in a sack the sack placed in a box the box locked and then dropped on a river bed

Here is the explanation It is well known that some people can develop by training special physical abilities like the ability to twitch one s ear at will Houdini had developed the physical ability of vomiting out the contents of his





Is this natural or supernatural ?

If you believe in the supernatural you may credit us with supernatural powers for producing the tap shown here which can supply you flowing water endlessly apparently without ever receiving a drop from any reservoir Such a tap was displayed at The method of science exhibition Would you conclude that we have *taught* the tap how to create matter from non matter—a supernatural explanation (an explanation in terms of the unknown)?

Or will you if you don t know how we have done it say I do not know and look for a scientific explanation?



Wouldn t you say it is only fair that before you conclude we possess supernatural powers you must be allowed to examine the tap at close quarters?

Abracadabra!

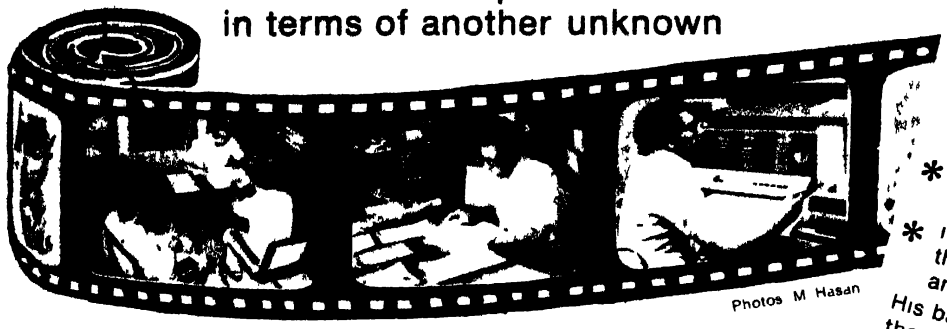
At a live magic show the performer does not claim any supernatural powers He says it is only a trick and nothing more In other words there is a scientific explanation for what he does

Watch carefully
Ask him questions and then question his answers
And see if you can guess how he does it

We conclude

If someone produces a rabbit out of a hat, or a watch out of nowhere he is performing a trick All magic is trick, with relatively simple scientific explanations

Science does not seek an explanation of the unknown in terms of another unknown



Photos M Hasan

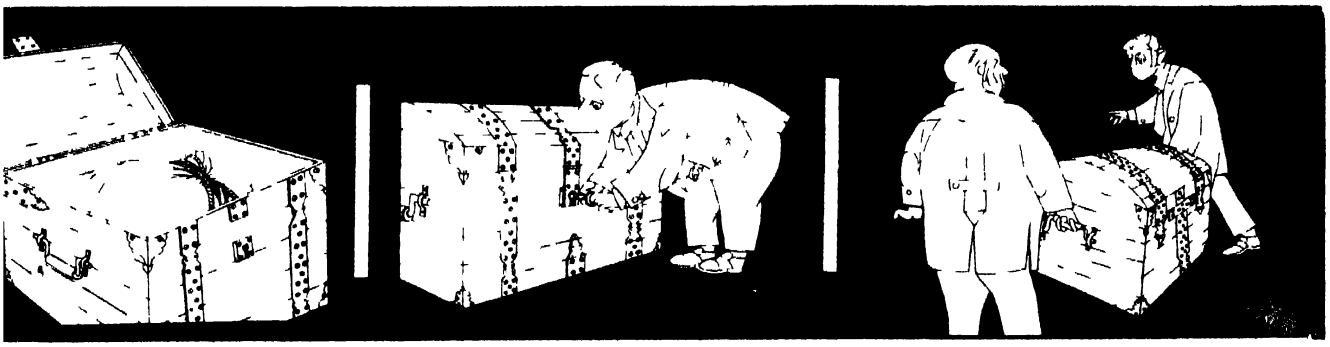
When a scientist does not know the answer to a question

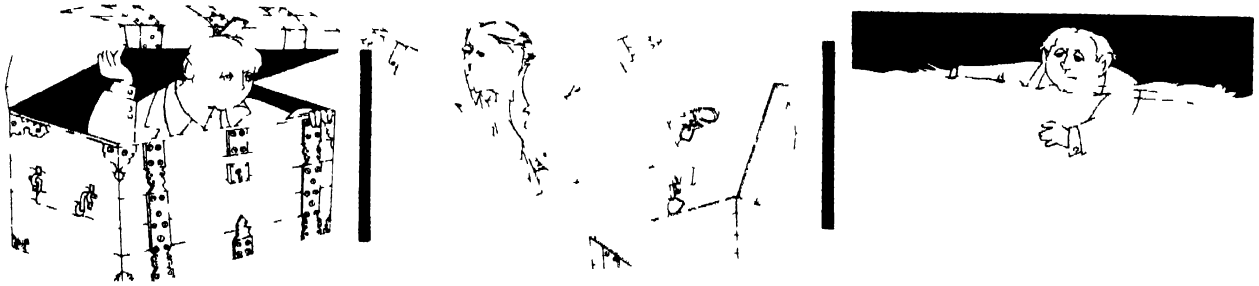
* he does not accept an 'unscientific' answer that is an answer which cannot be tested or verified scientifically and which is incompatible with the method of science
* he tries to find out if a scientific answer already exists
* if no such answer exists he uses the method of science to obtain an answer

His basic premise always is that, if the question is answerable, the answer can be found only through the method of science

Supernatural and magic

stomach at will Just before he was tied up, he swallowed a knife as well as the key to the trunk Physical search therefore never revealed him to be in possession of these objects (They would have, of course, been discovered on him—or rather, in him—if someone had decided to use X-rays!) To come out and swim ashore he only had to vomit out the gadgets cut open the sack and then open from inside the lock of the trunk If he had started claiming supernatural powers and set himself up as a godman he would probably have acquired an enormous following!





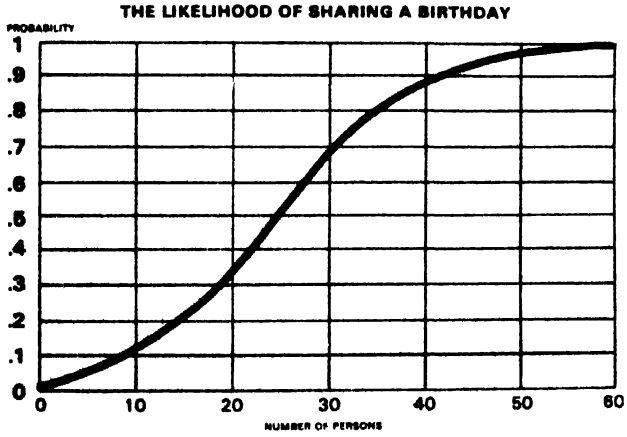
Illustrations Laxma Goud

And here is something to surprise your friends

If you are in a group of 60 or more persons, you may successfully take a bet that at least two persons in the group would have the same birthday

Would the reason for your success lie in your ability to communicate telepathically with others (explanation of the unknown in terms of the unknown), or in elementary statistics (explanation of the unknown in terms of the known)?

(For the answer, see graph at right)



The curve of coincidence The chances of two persons in a group having the same birthday rise sharply as the group s size increases Among 10 people the probability is 1/10 (expressed on the graph as .1), among 25, about 5/10 Above 50 the chance approaches certainty (expressed as 1)

No. 2
of a series
giving the facts about
India's new strike aircraft

jaguar INTERNATIONAL

design for production

Jaguar International is an aircraft specialised to meet India's defence problems.

It is supersonic.

It has outstanding payload/range performance.

It has short take-off and landing characteristics.

It can operate from semi-prepared strips.

It has twin-engine reliability.

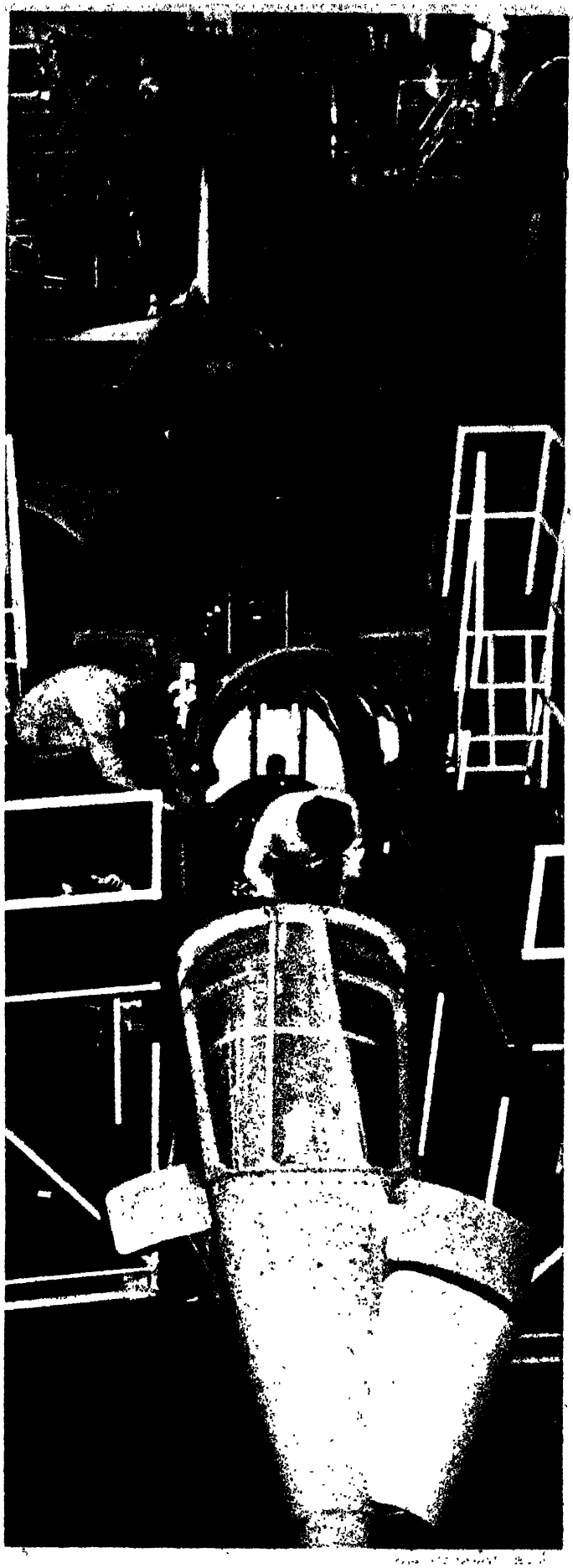
It has formidable air-combat capability.

It can accept long periods away from base maintenance facilities.

The two-seat version is a first-rate operational trainer which retains full strike capability.

Cost-effectiveness. From the inception of the project, the need to provide for joint production and parallel assembly lines in two countries was a fundamental design requirement on Jaguar. This demanded a high order of planning in manufacturing breakdown, backed by meticulous production engineering, with the result that Jaguar – although a sophisticated high-performance aircraft – is remarkably simple and straightforward to manufacture, assemble and maintain. This has helped to make it the most cost-effective military aircraft in production today and makes it an ideal choice for further development and production in India.

Designed for long service. Jaguar's airframe was designed to give long, trouble-free service in that toughest of roles – sustained lo-lo tactical support or interdiction missions. The integrity of structure and reliability of systems needed to meet this operational requirement were fundamental to achievement of the design aim of ensuring that Jaguar would have 95% certainty of carrying out each mission assigned to it.

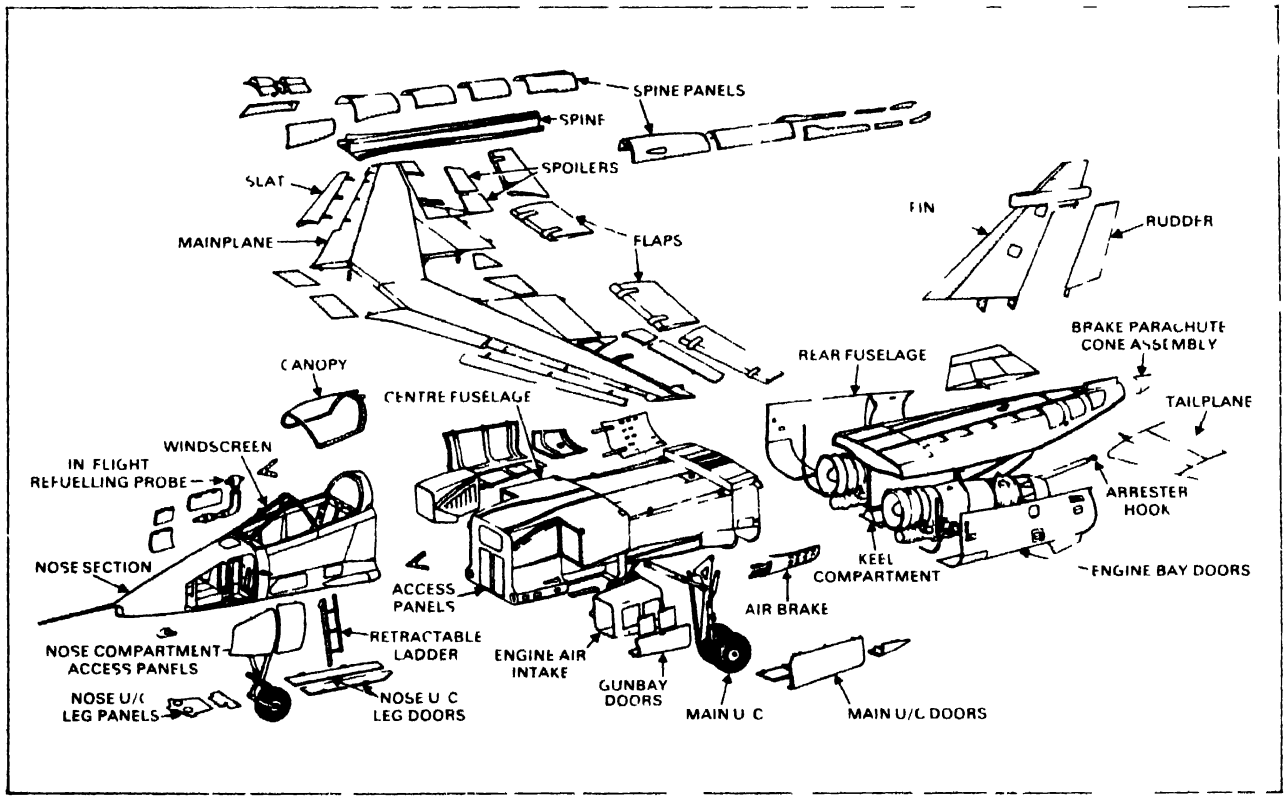


Rugged and straightforward. Although an advanced, supersonic aircraft, with very sophisticated systems, Jaguar is structurally rugged and straightforward This not only makes it straightforward to manufacture but also gives it high resistance to battle damage Its dependability and survival ability are further enhanced by duplication of the main systems self-sealing fuel collector boxes protected feed pipes and twin-engine configuration

Machined from the solid. Wing fin and tailplane torque-box skins are machined from solid aluminium-alloy billets to give strength and durability Considerable use is made in the front and centre fuselage sections control surfaces and flaps of aluminium honeycomb sandwich Stainless steel and titanium are both used in highly stressed areas and in the engine bays

Simplicity and strength. The exploded drawing illustrates the basic simplicity and strength of engineering concept which have made Jaguar one of the most trouble-free international collaborative projects ever undertaken and which have also earned it an outstanding reputation for reliability and ease of maintenance in operational service

Some 400 Jaguars are already in service with the air forces of Britain, France, and two other countries Now, after one of the longest and most thorough evaluations in aviation history, the Indian Government has decided not only to order Jaguar International but also to develop and build it in India



jaguar
INTERNATIONAL

To be developed and built in India by HINDUSTAN AERONAUTICS LIMITED, BRITISH AEROSPACE & DASSAULT/BREGUET, FRANCE.



Every drop of New Code 10 Tonic Hair Dressing nourishes hair, controls dandruff, gives your hair the natural look

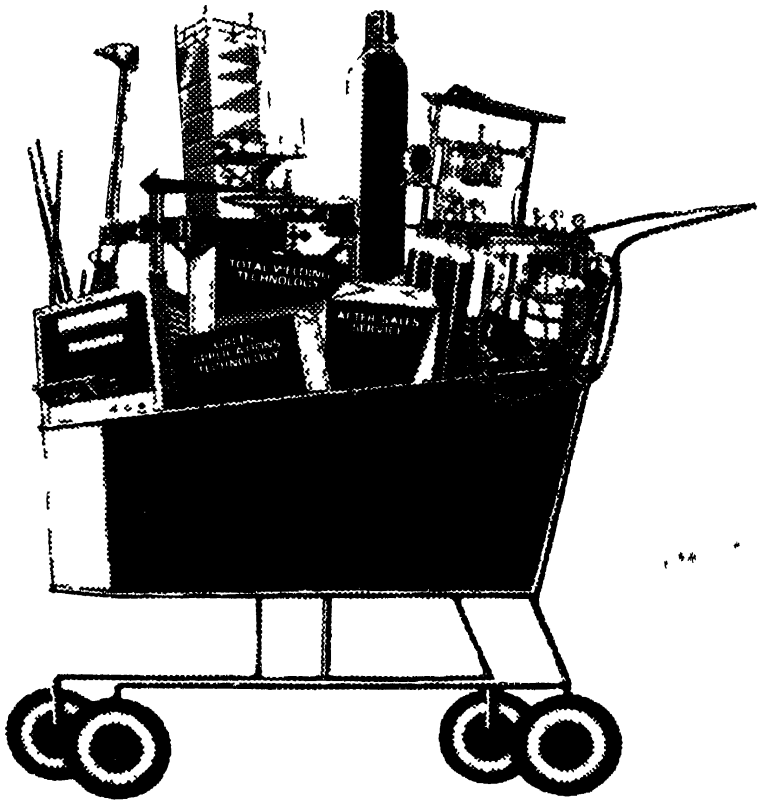
Code 10 contains Panthenol to nourish your hair give it vitality and bounce And LO 7, a proven anti dandruff ingredient to help fight dandruff

Whether you are a man or a woman give your hair the natural look with Code 10 every day It does your hair a world of good—and it doesn t cost the earth



Your secret code to healthy, well-groomed hair

THE TECHNOLOGISTS' SUPERMARKET



That's one way of describing the broad spectrum of IOL's technologies

The technologists' supermarket is IOL where under one roof a wide range of products and services are available

IOL's technological hamper includes gases for anaesthesia, welding, cutting, inerting, cryogenic applications and furnace enrichment, special gases for the electronics industry, for diving and off-shore operations, for metallurgy, calibration of instruments and research, anaesthetic equipment, welding and cutting equipment and consumables of every kind to meet needs as diverse as those from the wayside welder to the shipbuilder, the small tool manufacturer the giant heavy engineering sector petrochemical, fertiliser and refinery complexes plus entire gas plants, associated cryogenic equipment, and liquid oxygen explosives for mining

Backing this hardware is a package of services–consultancy and advisory after–sales, and training

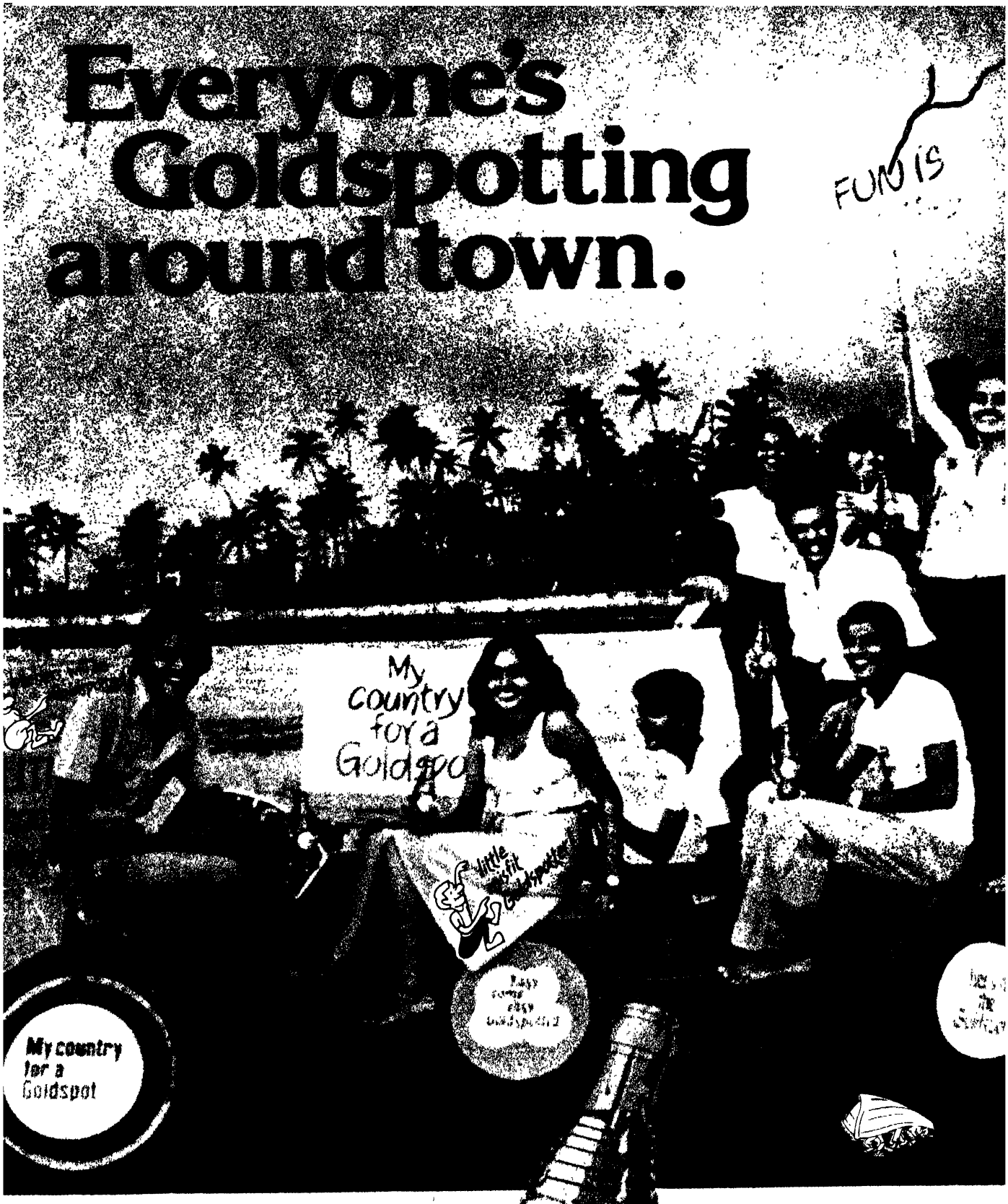
IOL's leadership in all its activities is the leadership of technology Cross-fertilising latest trends with existing knowledge to breed a new generation of products and services. For progress

IOL

IOL Indian Oxygen Limited

IOL offers the best in technology

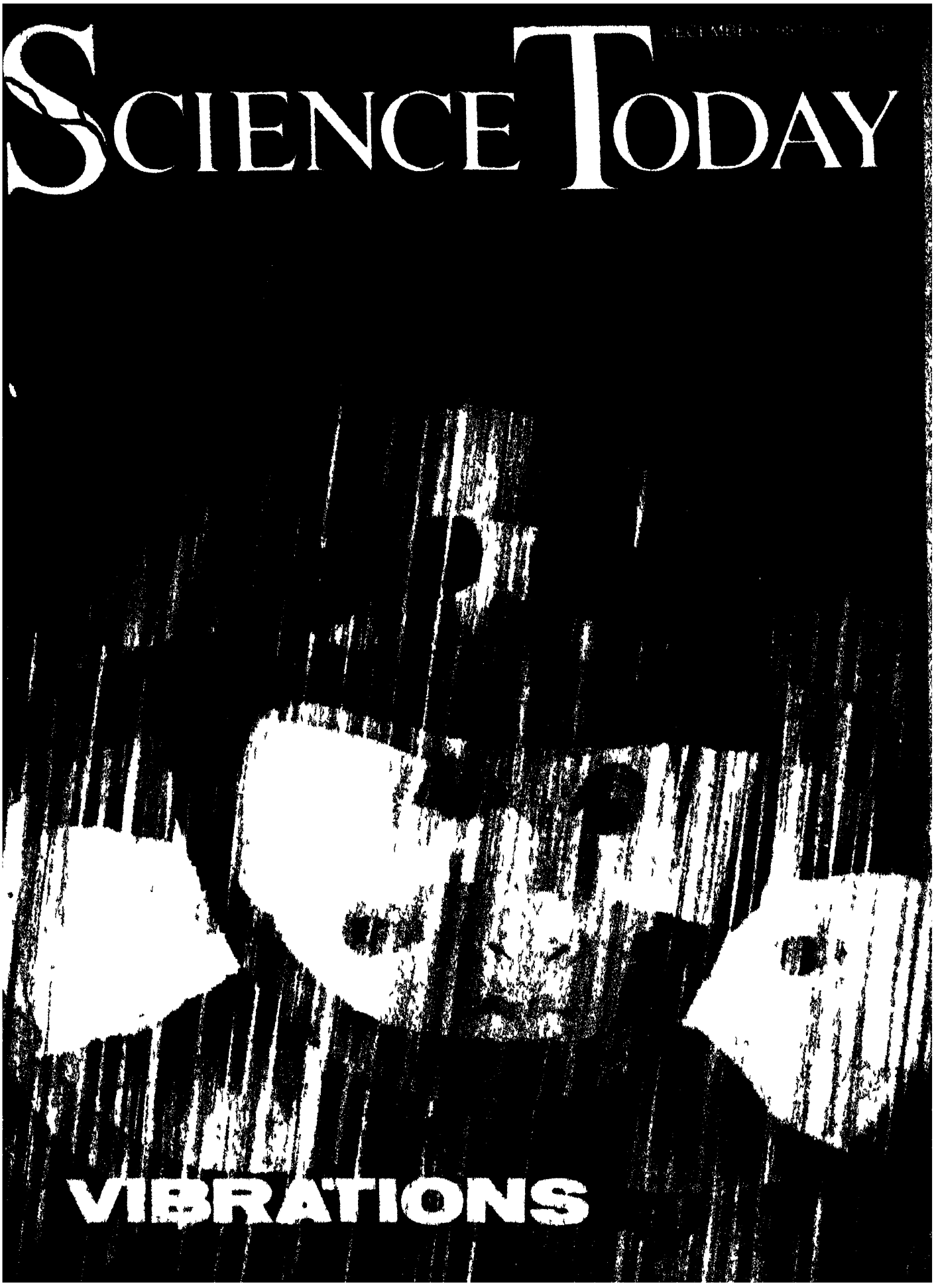
IOX/CAS-7/80



It's not just a new word.
It's a way of doing things...
a great new feeling for fun,
a feeling that comes out with
only one word... goldspotting.

ting... you'll like it

SCIENCE TODAY



Lijjat

PAPADS

GO WITH FOOD AND BEVERAGES TOO!



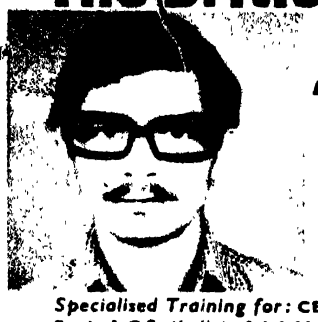
Lijjat PAPADS

GOOD AT ANY TIME

SHRI MAHILA GRIHA UDYOG LIJJAT PAPAD
3, Kamal Apartments, S V Road, Bandra (West) Bombay-400 050.
(Recognised by Khadi & Village Industries Commission)

BROTHERS/

"The British Institutes is doing yeoman service"



says Virendra B. Jain*

"By developing systematic educational facilities by correspondence....."

*Mr. V B Jain, Student No. DBM 289X, passed DBM (IMC) Examination in November, 1979 obtaining a First Class

and Thousands of other students agree

Specialised Training for: CERT. A.I.I.B., D.B.M. (I.M.C.), D.COM. (Bus. Org.), D.COM. (Banking), D.COM. (Accounts & I. Tax), D.COM. (Comp. Sec.), A.C.S. (India), A.I.A.M., C.A. ENTRANCE, A.M.I.E. (India), A.M.I. Mech.E. (INDIA), A.M.I.I. CHEM.E., A.M.Ae.S.I., A.S.E. (LONDON), N.P.C. SUPERVISORS and I.I.T. ENTRANCE EXAMINATIONS

We are recognised as an official training centre for Cert. A.I.I.B., D.Com. (I.M.C.) and D.B.M. (I.M.C.) examinations

● ALSO EXPERT COACHING FOR BANK PROBATIONARY OFFICERS' EXAMINATION

Career Oriented Diploma Courses in

COMMERCE: ACCOUNTANCY, COST ACCOUNTANCY, Banking, Income Tax Practice, Company Secretaryship, Salesmanship, PERSONAL SECRETARYSHIP, Shorthand (Pitman), GOOD ENGLISH, College English, BUSINESS LETTERS, BUSINESS TRAINING, German, French, Russian, Fiction Writing, ARTICLE WRITING, Reporting Stage, Radio & T.V. Writing, Writing for Children, COMMERCIAL ART, Personality Development

MANAGEMENT: BUSINESS MANAGEMENT, Sales Management, MARKETING MGT., Advertising, INDUSTRIAL ADM., Purchase Mgt., Materials Mgt., PERSONNEL MGT., Office Mgt., ManagementAccountancy, EXPORT MGT., Junior Executive's, MANAGEMENT EXECUTIVE'S, BUSINESS ADMINISTRATION

ENGINEERING: MECHANICAL ENGG., Mech., Draughtsmanship, CIVIL ENGG., Overseer's (Bldgs. & Roads), ARCHITECTURE, Textile Technology, TEXTILE MANUFACTURE, AUTOCODER PROGRAMMING, Industrial Engg., AUTOMOBILE ENGG., Diesel Engg., ELECTRICAL ENGINEERING & ELECTRONICS, Electrical Supervision, RADIO ENGG., TRANSISTOR ENGINEERING, Television, REFRIGERATION, Chemical Engineering, PETROLEUM TECHNOLOGY, Rubber Technology, INDUSTRIAL CHEMISTRY

Tools and Kits supplied for Radio Engg. and Transistor Engg. courses

Write today, send coupon, come personally or telephone 256755

THE BRITISH INSTITUTES

56, B19, P O Box 1025, 359, D. N Road, Bombay 400 023

THE BRITISH INSTITUTES, 56/B19, P. O. Box 1025, 359, D. N Road, Bombay 400 023

Send me a FREE Prospectus in the SUBJECT .....

Name ..... Education .....

Address .....



BUSINESS TOUR?



STUDY TOUR?



HOLIDAY TOUR?

Make it a success—with LINGUAPHONE

Today a second language is a social cultural and commercial asset It can open the way to success and greater enjoyment on your next visit to a foreign country

For full details, of French, German, Polish, Russian, Japanese, Spanish, Persian, Arabic, Chinese (Mandarin), Chinese (Cantonese), Malay, English, Intermediate & Advanced English, Hindi or any of the 38 languages write today, send coupon or come personally to

LINGUAPHONE INSTITUTE (Dept 56/FI9),
UCO Bank Building, Flora Fountain,
359, D. N. Road, Bombay-400 023
Demonstration Centres at: 13/1A, Govt. Place East, Calcutta 13, Daryaganj, New Delhi



Also available easy-to-carry travel packs in French, German, Spanish and Italian

LINGUAPHONE INSTITUTE 56/FI9, UCO Bank Building, Flora Fountain, 359, D. N. Road, Bombay 400 023

Please send me a FREE Prospectus for ..... (specify language)

Name .....

Address .....

WRITING FOR PLEASURE OR PROFIT?



Let ICS Home Study Courses develop your talent in JOURNALISM, Short Story Writing, T.V. Script Writing.

Also available.
Practical Photography, Dress Making, Pattern Cutting & Designing, Interior Decoration, Oil Painting, Fine Art, Commercial Art, Cartooning, Water Colour Painting, Portrait Painting, Poultry Keeping, Beauty Care & Personality, Etiquette & Entertaining, Flower Arrangement, Gardening

Other interesting courses for self development

Good English, French, German, Accounting & Auditing, Private Secretary's, Storekeeping, Public Relations, Hotel and Catering Mgt., Industrial Mgt., Business Mgt., Sales Management, General Mgt., Electrical, Mechanical, Civil Engineering, Electronics, Radio & T.V., Plastic Technology, Architecture, Cotton Carding & Spinning

Write today, send coupon, come personally or telephone : 256755

INTERNATIONAL CORRESPONDENCE SCHOOLS

56/D19, UCO Bank Bldg., Hutatma Chowk, P.O. Box 1931, Bombay 400023

INTERNATIONAL CORRESPONDENCE SCHOOLS
56/D19, UCO Bank Bldg., Hutatma Chowk, P.O. Box 1931, Bombay 400023

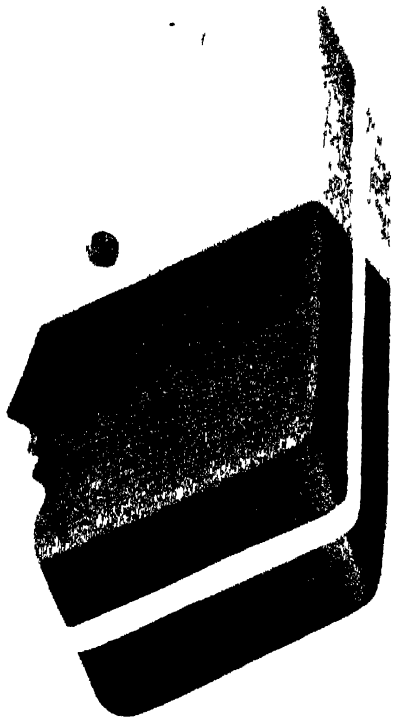
Please send me a FREE Prospectus in the SUBJECT .....

Name ..... Education .....

Address .....

NORVICSUN

Calibre: It's when you neither waste your guts nor play the dirty game, but start changing the rules.





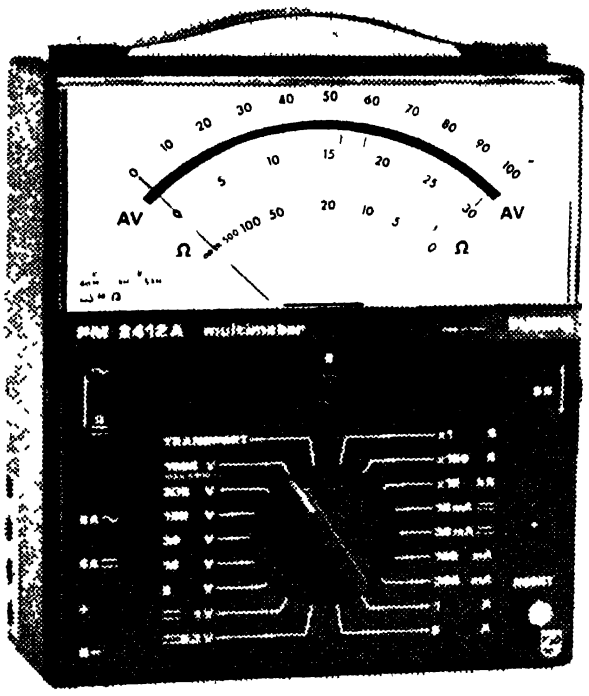
cali—ber: It's what some men look for in other men and all men look for in suitings.

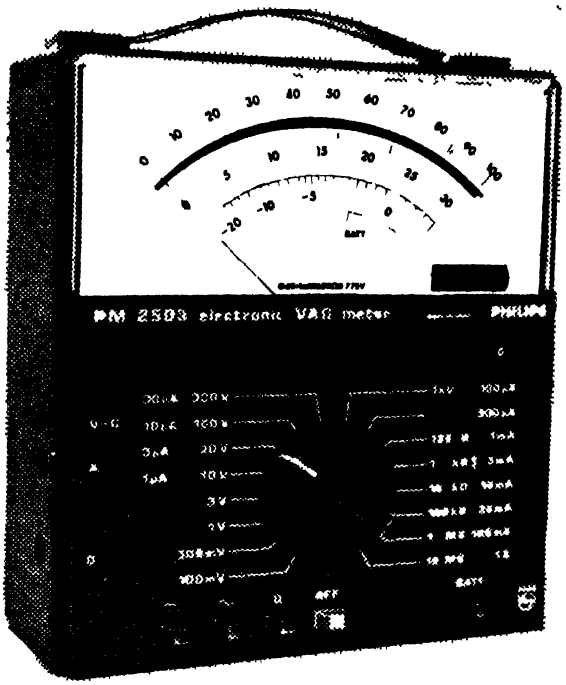
calico

Available at all Cali-shops and leading cloth shops

Rediffusion C/1232c

Philips makes you a safe and sensitive offer.





Philips PM 2412 A

Safe: Electronic cutout trips within milliseconds to protect your Multimeter up to 250 V Mains on any range.

Safe: Just switch to "Transport" position before putting the Multimeter into your briefcase.

Safe: Meets International Safety specifications IEC 348 for your safety.

Sensitive: 40000 ohms/volt sensitivity for accurate measurements.

Philips PM 2503

Sensitive: 100 mV F S. sensitivity from DC up to 30 KHz AC for all your Audio/HIFI work.

Sensitive: 1 μA F.S with 10 nano-Ampere resolution from DC up to 70 Hz AC— for leakage current measurements.

Sensitive: Resistance measurements to 10 Megaohms with Linear Scale for high accuracy measurements.

Safe: Comprehensive overload protection.

PHILIPS

Two export quality multimeters.

PHILIPS

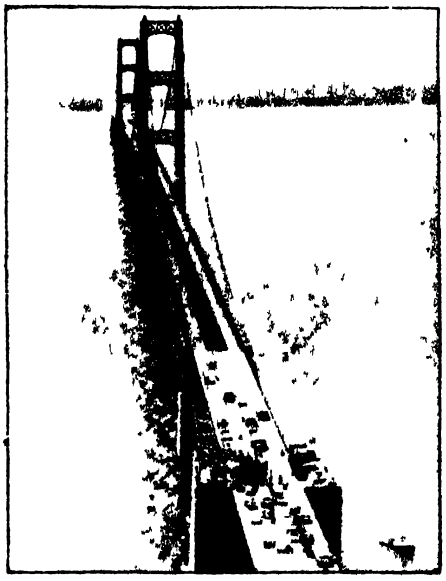
PH.51.4216

Science Today

December 1980 Vol 14 No 11

16 Vibrations, soldiers' steps and galloping cables
S Suryanarayan

The study of vibrations, particularly of machinery and vehicles, is becoming increasingly important for their designers



25 The come-back of malaria
S Subrahmanyam

Both the malarial parasite and its carrier, the mosquito, seem to have grown too clever for the chemicals used against them but vaccines hold out a hope

30 Environmental improvement for malaria
T Ramachandra Rao

Environmental improvement may help reduce malaria incidence considerably, but this needs a radical change in our approach

39 Nobel Prizes, 1980

Genetic engineering has swept the board this year bagging prizes both in chemistry and physiology

44 Discovering science and technology for the rural poor
Bhartendu Prakash

To the villager education means, above all the knowledge for bettering his lot



58 Utilising urban spaces
William H Whyte

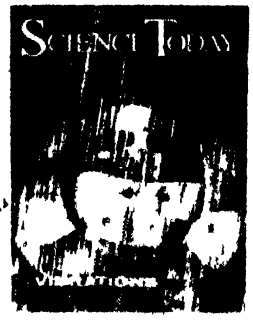
Whether life is worth living in the city of the future may depend on a more imaginative and balanced use of open spaces

66 The method of science - 11

Scientists all over the world use the same methods and the same techniques

7 Letters
10 Viewpoints
13 Science Shapes Life
33 Round-up of Research
37 This World of Science!
37 and of Scientists
43 Brain Teasers
48 Ideas & Inventions
51 If
55 Quiz (Birds)
65 Awards & Appointments
71 You Too Can Do It

10 Constitutional safeguards for scientists
71 LED power level indicator for stereos
51 If there is anti-matter
78 Index to Vol 14
55 How much do you know about birds?



Cover Nana Shivalkar

Editor
Surendr Jha

Single copy Rs 2 50
Subscription 1 year Rs 25
2 years Rs 49 3 years Rs 73

Editorial queries are to be addressed to the Editor, SCIENCE TODAY Times of India Building, Dr D N Road Bombay 400001 Unsolicited articles must carry adequate return postage

Subscription queries and payments should be addressed to the Circulation Manager SCIENCE TODAY Times of India Building Dr D N Road Bombay 400001

Printed and published for the proprietors Bennett Coleman & Co Ltd by T P Pithavala at Usha Offset Printers Pvt Ltd 125 Govt Industrial Estate Kandivli Bombay 400 067 General Manager Dr Ram S Tarneja Branches 7 Bahadurshah Zafar Marg New Delhi 110 002 139 Ashram Road Ahmedabad 380 009 105/7A S N Banerjee Road Calcutta 700 014 Offices at 13 1 Government Place East Calcutta 700 069 63 Montieth Road Egmore Madras 600 008 407-1 Tirath Bhavan Quarter-gate Pune 411 002 26 Station Approach Sudbury Wembley Middlesex London U K London Tel 01 903 9696

You save Rs. 278 every year on fuel bills with a Hawkins® pressure cooker



Your Hawkins pays for itself in the first year

Solve your kerosene problem

Kerosene is difficult to get and costs a lot Therefore, every effort must be made to use the minimum kerosene for cooking Modern science has a solution

Scientific, comparative cooking trials with the Hawkins pressure cooker have proved that on an average it consumes 53% less kerosene than cooking in the ordinary way Because cooking with Hawkins takes less than half the time of ordinary cooking you get similar savings if you use any other fuel—gas, coal, wood or electricity

The best investment

By using a Hawkins, an average family can save over half a litre of kerosene per day Saving on fuel alone would pay for your Hawkins in the first year itself Since Hawkins is made to serve you for years and years it is the best investment you can make today

You need not worry if you have never used a pressure cooker before Every Hawkins comes with a simple, illustrated instruction book, with 127 tested recipes The book is available in 12 Indian languages

Save on maintenance

Hawkins gives the least trouble The Hawkins gasket and safety valve last longer than in ordinary pressure cookers

The special Hawkins design makes it accident proof Because the lid opens downwards into the pot instead of sideways the lid cannot be opened even by mistake until the pressure inside falls to a perfectly safe level The safety valve is under the handle bar so that when it operates the steam is deflected safely downwards

Free service

Hawkins has a written guarantee for 5 years All parts covered by the guarantee are replaced free Hawkins service is always free There are Hawkins Authorised Service Centres with factory trained mechanics in 115 towns in India who provide prompt expert service

Invest in your family's health

You may not know it, but a Hawkins is also an investment in your family's health because it gives healthier food than ordinary cooking Studies by the Central Food and Technological Research Institute show that certain nutritive elements, particularly vitamins and proteins, are better retained in pressure cooking And Hawkins gives you more hygienic food because it cooks at 122 C the temperature used for sterilisation

Nowadays, you cannot afford to be without a Hawkins pressure cooker Buy a Hawkins at your nearest, most trusted dealer or write to the manufacturers Pressure Cookers & Appliances Ltd , P O Box 1542 Bombay 400 001



Hawkins®

® Hawkins and Hawkins Universal are Registered Trade Marks
© 1980 Copyright by Registered Users Pressure Cookers & Appliances Ltd

The trouble-free pressure cooker that's made to serve for years and years

LINTAS PCA 167 2518

THIS IS NO METHOD OF SCIENCE

IN WRITING this letter I have first to state that I do not have unquestioning respect for any medical system, including homoeopathy Also I have not taken any medical leave during my public service of 26 years

P M Bhargava's singling out homoeopathy for criticism bordering on ridicule however, vitiates against the method of science he professes (August 1980) Every medical system has its own rationale upon which diseases are diagnosed and medicines are administered and cures brought about Homoeopathy too has its own methodology and philosphy I refer in particular to the criticism of how administration of 1 24,000 000 gram per day of *natrum mur* (common salt) cures so many diseases All homoeopaths do not give this dose for all the diseases listed in Boericke's *Materia Medica* (two pages of which have been reproduced p 72) Many other bio-factors of the patient have to coincide to enable this dose of the drug to act Dr Bhargava's suggestion that homoeopathy claims a long list of ailments as curable by *Natrum mur* is against the method underlying the homoeopathic system of medicine Further his suggestion that minute amounts of salt taken would not make any difference (as we already take massive quantities) is unscientific because the homoeopathic system itself is based on the principle that extremely small doses of even common materials can have potent curative effect Dr Bhargava's argument may be countered if we consider another principle of homoeopathy a massive dose of snake poison or arsenic would cause death, whereas administration of the same materials in homoeopathic doses is claimed to cure the effects of those poisons

Again the psychosomatic explanation for homoeopathic cures put forward by Dr Bhargava cannot hold Homoeopathic pills administered to a few days-old babies animals and even to plants have brought about cures I am not defending the homoeopathic system but only arguing that the system is as scientific as other systems of medicine

S D Thirumala Rao
Director
Oil Technological
Research Institute
Anantapur 515 001

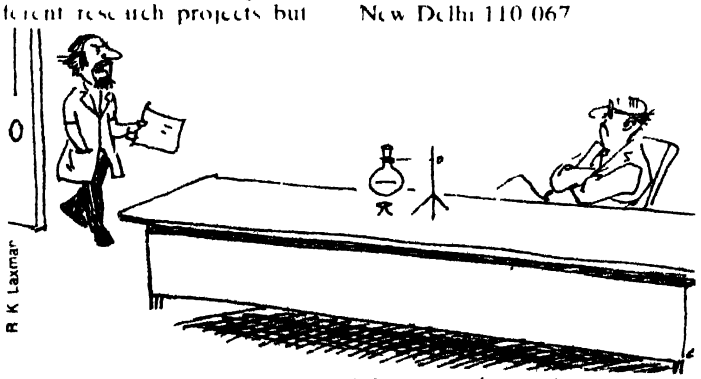
THE NEED FOR FUNDS

ONE BASIC reason for the position in which Indian science has landed itself (Viewpoints April 1980) is the lack of adequate funds for research in universities which have been relegated to the position of factories for giving BA BSc MA and MSc degrees Slowly even the emphasis on research and funds for it have declined The days of isolated geniuses working without modern analytical tools money or proper teams are long over In order to compete at present with international science one needs not only bright ideas but also the facilities to work these through In volume of research India ranks among the top six countries but from Garfield's impact rating way down and in general the quality is poor

No doubt many agencies in India are now funding different research projects but most of these are small grants, often inadequate even to buy items like radiochemicals Basically, they help only in overcoming the problem of unemployment for young MSc graduates on a short-term basis and enable some of them to put out some kind of publications Instead of spreading the butter too thin I feel that good projects and worthy scientists should be financed to the fullest extent possible to get the maximum out of research inputs In fact it would be worthwhile if some scientists irrespective of age position and contacts (sadly the last factor often overrides others) and institutions are identified and brought together as well knit homogenous working groups instead of everyone doing a bit-bit here and there

Frank Press President Carter's science adviser recently made a statement that best science was combined with graduate education Is this realised here? I am sure many will agree that doing science is a constant source of frustration for most juniors The conditions under which a scientist works in India except at a few places are miserable Prof Maheshwari has mentioned that places like the Jawaharlal Nehru University (JNU) attracting many students and has pointed a finger at some of us who left Delhi University I did so many years ago because I realised the high degree of conservatism and lack of opportunity for progress where promotion based on seniority had become deeply entrenched

Sudhir Sopory
Associate Professor
School of Life Sciences JNU
New Delhi 110 067



There is a further cut in research funds, professor because we haven't shown much by way of results

RESEARCH AT PRL

DR SHARDANAND'S Viewpoints 'Is PRL Science Relevant to India?' (September 1980) is in keeping with the prevailing fashion of running down institutions of scientific research But, on his own admission, the quality of work going on at the Physical Research Laboratory is of very high standard Such misplaced criticism as Dr Shardanand's is detrimental to the interests of the nation

K P Joseph
Scientific Officer
Chemical Engineering
Division, BARC
Bombay 400 085

GOVERNMENT, SCIENCE AND TECHNOLOGY

PROF I I Rabi (Blurs and Bright Spots September 1980) attributes the sagging morale of science and technology to (a) the excessive concern for environment and non-human life, (b) the excessive social demand for safety and reluctance to take up hard challenges, and (c) intellectual trends shifting from hard to soft' sciences Prof Rabi's contention warrants examination Today's concern for environment is tomorrow's concern for mankind Excessive concern for environment today is by way of making amends for the excessive unconcern and misuse in the past

Dr Rabi classes so-called soft sciences (presumably life and behavioural sciences) with superstitions Environmental medical and psychological phenomena are increasingly proving the unjustified and arbitrary mental frontiers dividing soft' and hard' (presumably physical) sciences The real challenge in science and technology, however, lies not in isolated advances in soft or hard sciences, but in the co-ordinated and integrated future growth of all sciences The sagging morale can be attributed to narrow specialisation inadequate humanistic spirit among the persons involved and a prejudiced and orthodox approach on the part of so-called hard scientists—and

not to the factors mentioned by Dr Rabi

A K Chandra Shekhar
H/51 MIG Colony
Indo e 452 008

SONOCHEMISTRY

THE use of ultrasound to catalyse chemical reactions is not all that new (Sono chemistry—a new discipline, Ideas and Inventions, September 1980) Weissler (*Chem Engg Prog Sym Series* No 1 47, 22, 1951) did an extensive study on the iodine clock reaction under ultrasound irradiation at high frequency (400 and 1000 kHz) and found that the reaction rate was influenced by variation in sound intensity duration of exposure reaction vessel, distance above the transducer, wall thickness of reaction vessel and pressure of a particular gas An outstanding example is the US Bureau of Mines development of a hydrogenation process for low-grade coal using ultrasound

Sonocatalysis has been very successfully tried for advanced waste water treatment Oxidation of phenol, one of the most common and toxic organic compound in wastes, was studied It was found that ultrasound energises the surface of the catalyst (Raney-Ni and MnO) and increases the rate of surface reaction The effect of sonocatalysts is much more than the addition of the individual effects of catalyst and ultrasound

Chetan Y Joglekar
Final Year
Dept of Chem Engineering
University of Bombay
Bombay 400 019

SOCIOBIOLOGY: NEW PSEUDO-SCIENCE?

THE TWO articles The Evolution of Behaviour by Madhav Gadgil and How Selfish is the Selfish Gene? by Sumati Sampemane (March 1980) are part of the recent attempts to spread misconceptions about organic evolution Interestingly enough, most of its propounders are from Harvard with the blessing of Prof William Shockley Although there was another article by V Nanjundiah which was much more balanced and pointed out some of the falsity of this theory and the dangers inherent in Hamilton s classification, it can hardly justify the coverage

The misinterpreted and false premises adopted in these theories are as follows First, the presentation of Hamilton s classification of animal behaviour in terms of some popular description of human psychology, as something fundamental and scientific Such extrapolation cannot be scientific particularly if these traits are attributes of one s social personality There are certain traits in human behaviour which are also found in animals (like hunger and fear) because of the dominance of pathological factors But selfishness and altruism if at all we accept them as independent traits, are different facets of the human personality which is unique because the evolution of human civilisation is unique

Second it assumes without proving (and it is impossible to prove) that all these behavioural patterns are genetically determined and controlled by the mystifying motivations of individual genes, which according to the authors, increase the number of their own genotype through competition

In fact while talking about the genetic basis of the behaviour of animals we can at best talk about certain correlations and not about any causality, since the number of genotype-environment interactions can be effectively unlimited and from one genotype different phenotypes can be produced Most of the examples, chosen subjectively by the author to prove his theory of selfish genes, can be understood in a much more rational way For example, in the case of bees, the inability of worker bees to lay eggs is due to their inferior nutrition during growth, compared to the queen bee This again can be well understood from the point of view of ecological balance bet-



There's a moment in your life for UCOBANK

She simply fills your days with happiness. Soon you'll want to present her the happiest day in her life.



Give us that moment and we'll give your daughter the marriage of your dreams

Come to us with what you can put aside and we'll show you how you can give your daughter the marriage of your dreams.

UCOBANK has many schemes that will help multiply your savings.

We'll show you the profitable combinations of these schemes to make your savings grow quicker.

By earning more.

Visit any of our branches.

Happiness for your daughter on her wedding day begins with the moment you decide to make her such a present.

Bring that moment to UCOBANK

United Commercial Bank
the friendly bank round the corner

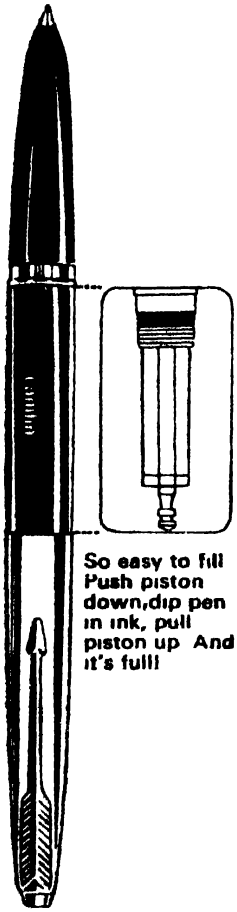
UCO CAS-62/80

new

UNMATCHED

camlin
PISTON PENS

No time wasted No messing up with ink Camlin Piston Pen mechanisms make it just easy Fill up and feel the difference



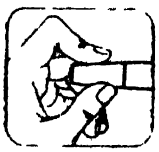
So easy to fill Push piston down,dip pen in ink, pull piston up And it's full!

INJECTION PISTON PEN 48



Rotate anticlockwise - the air comes out.

Rotate clockwise- ink fills to the brim.



PISTON FILLING PEN 47

S 793

ween bees and their micro-environment—food resources and building material, etc—if we take into account that fact that a queen bee can lay more than two million eggs after a single mating Besides, there is no dearth of examples which contradict directly the theory of genetic profitability For example, male cats often kill their own offspring carrying 50 per cent of their genes A black widow spider, when hungry, resorts to eating its own offspring Attempts to explain such complex behavioural pattern of animals by the arithematic of genetic profitability will be a futile exercise, unless we are out to explain something else

The genetic theory of evolution has been explained quite amply by Dr Nanjundiah in his article and it is necessary to understand the misinterpretations involved in Dr Gadgil's approach The first thing to be noted is that Dr Gadgil has consistently avoided the fact that continuous mutations occur in genes These mutations leading to the changes in the properties of new genotype combined with the struggle for existence, constitute the proper theory of genetic evolution

It must be understood that these pseudo scientific theories try to offer some apparently scientific basis for human behavioural patterns which are really the product of an unjust social order based on profiteering, competition, private property and the tyranny of the few over the majority Fortunately, it is a fact that such theories never gain much nor confuse people for a considerable time

Biswaranjan Ghosh, Amlan Chakroborty, Kalyan Guha, Subhas Mondal, and S Mitra
Science Education Group
IIT, Kharagpur

HORMONE TESTS

IN 'HORMONE Test Can Be Misleading' (Science Shapes Life, June 1980), the immunological method depends on the immunological property, not on the biological function of the hormone or protein to be measured or detected In certain biological macromolecules (proteins, etc) the parts of the molecule involved in the immunological reaction (immuno reaction) are not biologically active Thus, proteins which have some immunological property or immunoreactivity can have different biological functions In such cases, the immunological methods may lead to wrong identification or estimation of the substance as it is observed in the case of the beta-endorphin fragment Yet immunological tests cannot be totally discarded In many cases immunological tests, combined with a biological method, can provide better clues This can be well illustrated by an example

Certain carcinomas produce ACTH (Adrenocorticotropic hormone) But patients may not be showing any recognisable endocrine syndrome though the immunoassay shows an elevated plasma level of ACTH In such subjects, plasma level ACTH is normal by receptor assay (a kind of biological assay) This is because the ACTH produced by the carcinoma is not biologically active Thus the presence of immunologically active ACTH in the abnormal case can only be detected by immunological methods A binocular vision is to be established in order to solve such related problems

N Sivaprasad
Isotope Group
BARC Bombay 400 085

CONFERENCE ON BURNS

THE FIRST Afro-Asian Conference on Burns will be held in Bombay from 14-16 January 1981 It is jointly sponsored by the Burns Association of India and the International Society for Burn Injuries The theme of the Conference will be Prevention and Management of Burns in Developing countries Details may be had from S Agarwala Organising Secretary Burns Research Unit, Bai Jerbai Wadia Hospital for Children, Bombay 400 012

Constitutional safeguards for scientists

EQUALITY before law is a basic concept in a democratic society. Fundamental rights are a basic constitutional right of every citizen. Yet lakhs of employees in various public institutions like the Council of Scientific and Industrial Research (CSIR), Indian Council of Medical Research (ICMR), Indian Council of Agricultural Research (ICAR), Indian Standards Institution (ISI) and other similar organisations, wholly funded by the government, have been disfranchised. Their basic rights have been truncated; they cannot exercise their fundamental service rights under the law. Obviously, this denial of fundamental rights to a section of the population is a negation of the democratic process. This lack of constitutional safeguards for scientists has wrecked the working of scientific institutions in this country.

These rights are available to government employees and also to private industrial workers. Job security safeguards are available to the scientific community, even in the developed nations. Towards the end of last year, 4,000 scientific and technical French researchers, enjoying the rank of civil servants, marched through the Paris streets to protest against the French government's proposed reforms of the country's highly centralised research organisation, bringing job insecurity for scientists (*Nature*, 29 November, 1979).

In India, however, nobody, including the courts of law, could check the unlawful, arbitrary and malafide actions of the authorities in the scientific institutions. When the actions of the ICAR, CSIR, ISI and others have been questioned, the courts have accepted the technical plea taken by these organisations that being autonomous, the courts cannot interfere. This is because the institutions have been set up as non-statutory societies. And the law holds these non-statutory organisations, existing as societies, to be private, voluntary associations where a master-and-servant relationship prevails. The organisations are not amenable to the writ jurisdiction of the courts, and its employees have no legal rights in service matters to get their grievances redressed. If such an organisation commits any mistake, then the way to correct it is either political, administrative or legislative and not by way of resort to courts. It has also been held by the Delhi High Court in 1975 that "in the employer-and-employee relationship not regulated by statute or statutory rules, the question of malafides cannot arise. If the employer is inimically disposed towards the employee, the employee has got no legal right nor is the employer under any legal obligation as can be the subject matter of a writ petition which gives only public law remedies while the master-and-servant relationship is private and contractual in the eyes of law." Apparently, these organisations have been functioning beyond the pale of law; the authorities occupying top positions in these organisations have been enjoying all the privileges and benefits of a government office without any obligation or responsibility towards their employees since they are not answerable and accountable.

Elsewhere, it has been stated that the Indian scientific organisations are extremely hierarchical and bureaucratic establishments where success of a scientist depends on patronage and where scientists have turned into scientist-bureaucrats. The big laboratories are the "Taj Mahals" of Indian science, built to glorify and bury it. In this bureaucratic system, the directors-general of the various scientific bodies enjoy absolute powers to decide the destiny of thousands of young scientists working in these organisations, and to direct science in this country.

Consequently, autonomy in these organisations has been exploited and abused by persons in authority. They have built up a coterie of "yes-men" as privileged scientists by giving them extraordinary favours, like awards, foreign visits, promotions, research facilities, staff, students and other amenities at the cost of honest scientific workers. Though, by itself, the concept of autonomy is attractive, where public life is polluted with corruption, and where there is scant regard for moral values, autonomy has proved disastrous. Autonomy in these organisations was intended to make them free from bureaucratic practices under the government, but these organisations continued to suffer from the same practices. The Gajendragadkar Committee (set-up some years ago) report says that in actual practice, the ICAR has more often than not sacrificed its autonomy in favour of government rules and regulations and has followed government rules and procedures for purchase of equipment and construction of buildings. The Committee remarked that to call the ICAR a society was a myth. Accordingly, the Committee recommended that the ICAR be converted into a government department. Besides, the existence of widespread discontent and frustration among the working scientists of the ICAR and the prevalence of unscientific practices as revealed by the Estimates Committee of the 5th Lok Sabha and by the Gajendragadkar Committee and the various press reports from time to time, bore testimony to the failure of autonomy. The Association of Scientific Workers of India once expressed the view that a mere replacement of the IAS men by specialists in the present hierarchy will not redeem the situation because pomp has induced even scientific personnel to adopt the same attitude as administrators with ludicrous consequences. As a result, it cultivated the forces of authoritarianism and a personality cult which destroyed the very concept of science in these organisations. In a corrupt society, (a) autonomy has degenerated into autocracy, giving unfettered powers to top scientists to act in an authoritarian manner and build up their "empires"; (b) in the present system of autonomy, all principles of justice have been thrown overboard by openly subverting and flouting rules, regulations and administrative procedures; (c) autonomy has perpetuated slavery because of the existence of master-and-servant relationship and has reduced a scientist to the level of a slave to be exploited by persons in authority; (d) autonomy has provided opportunities to top scientists to indulge in fraudulent claims in falsifying research data for their self-glory and "eminence", and when their frauds are exposed, they have exploited their key positions and political influence to hoodwink the public and the government by taking shelter under the cloak of autonomy; (e) the fruits of autonomy (authority and freedom) have been enjoyed only by top scientists, while there has been no autonomy for the working scientists who do not have even the freedom of expression in scientific matters; (f) there is no accountability, and working scientists have been deprived of their constitutional service rights for getting their grievances redressed, denying them all avenues to seek justice; and (g) because of the concentration of power, top scientists

The rights of scientific researchers

The General Conference of the United Nations Educational, Scientific and Cultural Organisation made the following recommendations on the status and working conditions of scientific researchers at its eighteenth session held in Paris in November 1974.

The General Conference recognised that a cadre of talented and trained personnel is the cornerstone of an indigenous research and experimental development capability, and it is indispensable for the utilisation and exploitation of research carried out elsewhere; and that open communication of the results, hypotheses and opinions (as suggested by the phrase 'academic' freedom) lies at the very heart of the scientific process and provides the guarantee of accuracy and objectivity of scientific results. One of the essential conditions to encourage and assist indigenous research capability is to ensure a fair status for those who actually perform research and experimental development, "taking account of the responsibilities inherent in and the rights necessary to the performance of that work"

The General Conference recommended that the member nations should ensure that young people of high calibre find sufficient attraction in the vocation and sufficient confidence in scientific research and experimental development as a career offering reasonable prospects and a fair degree of security. Conditions should be encouraged so that scientific researchers have the right to work in a spirit of intellectual freedom to pursue, expound and defend the scientific truth as they see it. Opportunities should also be cultivated for scientific researchers to participate in the outlining of national scientific research and experimental policy; these processes should be supported by appropriate institutional mechanisms. In the performance of publicly supported scientific research, scientists should respect scientific accountability while at the same time enjoying the degree of autonomy appropriate to their task and to the advancement of science and technology.

Employers of scientific researchers should seek to regard it as a norm that scientific researchers be at liberty and encouraged to publish the results of their work to minimise the restrictions placed on scientific researchers' right to publish their findings consistent with public interest and the right of their employers and fellow workers; to express as clearly as possible in writing, in the terms and conditions of their employment, the circumstances in which such restrictions are likely to apply; and to make clear the procedures by which scientific researchers can ascertain whether the restrictions apply in a particular case and by which he can appeal.

The General Conference also recommended that scientific researchers should associate to protect and promote their individual and collective interests in bodies such as trade unions, professional associations and learned societies, in accordance with the rights of workers in general. These organisations should have the right to support the justified claims of scientific researchers where it is necessary to protect their rights.

The General Conference emphasised that these recommendations applied to all scientific researchers irrespective of the legal status of their employers or the type of organisation or establishment in which they work. Member countries should apply the provisions by taking whatever legislative or other steps required to implement the principles and norms involved in the recommendations Besides, the General Conference asked member countries to bring these recommendations to the attention of authorities and institutions responsible for conducting scientific research and various organisations representing or promoting the interest of scientific researchers.

have developed a temperament similar to that of IAS officials to act like bureaucrats and to rule like a scientocracy

This lack of constitutional safeguards and the means of redressal have driven some scientists to commit suicide The widespread frustration and dissatisfaction among working scientists have been reported by the Gajendragadkar and Sarkar Committees which also enquired into the irregularities and malpractices prevalent in the ICAR and the CSIR—two of the biggest scientific organisations in the country Their reports showed rampant favouritism and nepotism in appointments, suffocating working conditions, lack of freedom of expression and prevalence of scientific corruption for the sake of self-glorification The Gajendragadkar Committee observed that 'the malaise which they had observed was not confined to the ICAR but, barring minor exceptions, pervaded the entire scientific and academic community of the country At root, it is greed for bureaucratic power and love of a comfortable life which afflicts this class" The committee also remarked that in the present circumstances, a crisis of character and confidence has overtaken the entire administration of the ICAR and it is necessary that the recruitment of personnel in all the institutes with the ICAR should revert to the Union Public Service Commission

The Sarkar Committee reported corruption in the CSIR as many as 11 of its laboratory chiefs have been censured for irregularities by the Vigilance Commission

In order to create confidence among working scientists and to eliminate the forces of authoritarianism and personality cult it is necessary to provide adequate statutory safeguards in these institutions so that they could function democratically within the provisions of law In a democratic society it is necessary that public institutions with governmental funding are subjected to public scrutiny and judicial review public accountability of public funds in any institution, whether in the public sector or autonomous bodies financed by the government is essential For this purpose, all these autonomous scientific organisations financed by the government should, under a law of Parliament, be declared public institutions subject to public scrutiny and judicial review so that their employees are provided protection under Articles 14, 16, 32 226 and 311 of the Constitution of India

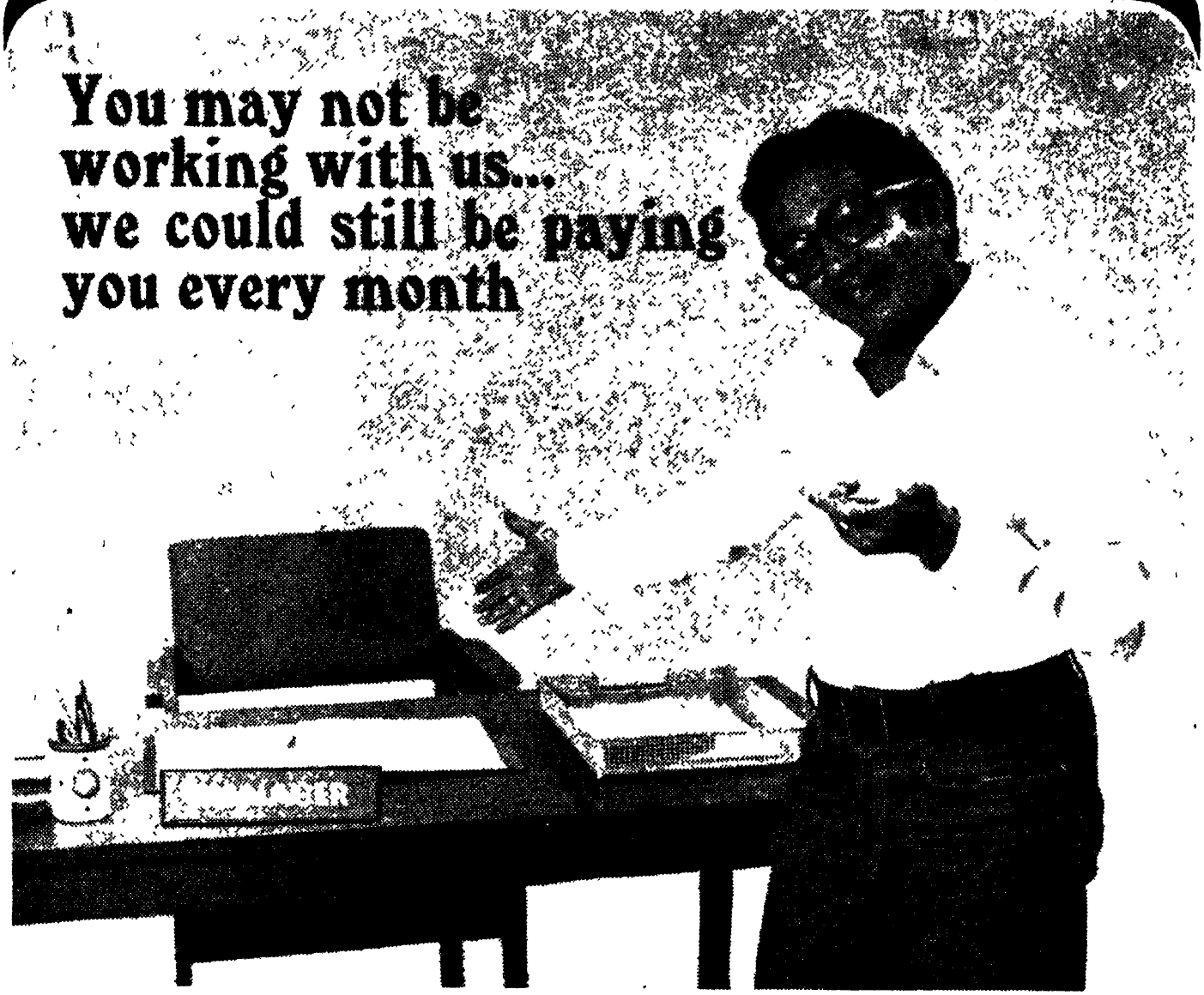
Y P GUPTA

Dr Gupta is a senior scientist in the Biochemistry Division at the Indian Agricultural Research Institute New Delhi



This year the arrival of the black-necked crane is being welcomed in the personal column of the Audobon Society

You may not be working with us... we could still be paying you every month



A Tall Talk !

Oh no ! A deposit under our **Special Fixed Deposit Scheme** ensures you interest from PNB every month

A deposit of Rs 30,000 for 63 months will fetch you Rs. 247.92 every month.

Interest upto Rs. 3,000 from bank deposit together with interest from other specified investments is free from income tax.

Open an account today and let us pay you interest every month.

punjab national bank

(A Government of India Undertaking)

... the name you can BANK upon !

Science Shapes Life

COOLING BEDS FOR HOT PILGRIMS

The annual Muslim pilgrimage to Mecca, the Haj, falls in different seasons each year because it is based on the lunar calendar Thus next year, millions of pilgrims will trek through the burning desert summer in the Muslim heartland Many of them will probably suffer heat exhaustion and heat strokes

When Haj fell in summer in 1961, many pilgrims died Now the Saudi Arabian Ministry of Health is better equipped to treat the stricken pilgrims It involves a new method which has been developed by two researchers, Prof J S Weiner and Mustafa Khogali, at the London School of Hygiene and Tropical Medicine The traditional ice-cold bath can be easily replaced by the new convenient method During an ice-cold plunge, they found, it took 40 minutes for patients to stabilise their body temperatures also, the whole process was painful and the volunteers undergoing the experiment shivered continuously The new method consists of a mesh bed slung over a water bath and a continuous spray of warm (32°C) water sprinkled over the victim's body This body cooling unit, besides providing a comfortable recovery, is five times quicker than the traditional method Apart from cooling the body it also relieves dehydration

During trials last year an earlier model of this cooling bed had saved all but two of the 18 victims And these two who died, were diabetics, heat-stroke is always more serious for diabetics



"Beats the heat all right, and a thing like that which keeps the head cool could ensure peace and stability in the Middle East"

BIRD SUICIDES IN THE NORTH SEA

Gas flares over the North Sea oils rigs are visible over long distances against the completely dark background of the winter The natural gases from oil rigs cannot be exploited fully and therefore have to be burnt off some 40 to 80 metres above sea level Migratory birds going to their winter homes in warmer climates are attracted to these flares, as moths to a flame, and are roasted alive During September and October the tolls are the highest, particularly during foggy weather

British ornithologist Bryan Sage who managed to get some information regarding the bird deaths says the first accident occurred in 1973 The oil companies have refused journalists access to oil rigs to study the phenomenon, yet one Norwegian journal was able to get some information from two offshore workers that starlings and thrushes were among the maximum killed Sage says that according to some workers on the rig, in the night of 25-26 October 1977, 1,500 dead birds were counted on the platform of an oil rig But since many roasted birds would have fallen directly into the sea, the toll may have been as high 3,000 at that spot The exhausted birds literally catch fire and plummet into the sea forming small smoke clouds as they hit the water

Most oil companies ignore the problem totally and protests have not been able to move them Only British Petroleum seems to be willing to let an ornithologist study the problem Protective measures can be taken only if one knows the details involved

THE ROLE OF A FRIEND DURING CHILDBIRTH

Childbirth can be easier with the moral support of a friend, according to R Sosa I Kennell M Klaus, S Robertson and I Urrutia In all but one of 150 cultures studied by anthropologists, the scientists say, a family member or a friend stayed with a woman during labour and delivery How important is the presence of a friend is just what these scientists investigated

In Guatemala South America it used to be a common practice to have a doula or companion during childbirth The immense population pressure has nearly put an end to this practice and now Guatemalan women deliver their babies in the clinical coldness surrounded only by strangers, much in the same way as modern Western mothers

Sosa and his group studied two sets of primigravid women Both experimental subjects and controls were selected randomly Twenty experimental women were to have doulas simply to hold hands or chat with The researchers ignored results from any women with complicated labour such as fetal distress, cesarian section or forceps delivery.

In the control group they had to ignore 83 women before they could line up 20 normal cases, whereas in the experimental group only 13 cases had to be ignored before lining up 20 normal cases The results of the study were quite surprising First of all, the labour was shorter for women with doulas—8 7 hours compared to 19 3 hours for the doulaless controls Also, the mother and child bond seemed to be stronger in the experimental group, they were awake more, spent more time stroking, smiling and talking to their newborns than did the controls The likelihood of development of certain problems that require intervention during labour was lower for doula accompanied mothers Probably her very presence eases the possibility of acute anxiety leading to complications Also women who were awake for 40 minutes or more after delivery were found to be more affectionate to their children at one month than mothers who fell asleep immediatly after delivery How far into the infant's future' development such benefits reach is not known but further studies may reveal whether it be worthwhile to reintroduce this low-cost method to improve the labour conditions for women

MAGNETS IN MAN

We can see, hear, feel smell and taste but how many of us can sense the directions? Would we feel different if we changed our position with respect to the earth's magnetic field? And then, the question arises, which part of body or organ feels the tug of the magnetic field?

Birds, bees and bacteria have magnetic materials within them that tell them about their orientation with respect to earth's magnetic poles Now comes a study from the UK which suggests that humans, too can sense the field

R R Baker at the University of Manchester UK, began a series of experiments on students to test for the magnetic sense in humans Blindfolded students were displaced from their original location over a complex winding route between six and 52 km On arriving at their destination by van each student had to do three things 1) tell which was north, 2) point to the direction where they thought was their university from where they started and 3) after removing the blindfold, point once more to the direction of the university It was found that when blindfolded, they performed more accurately

The students were asked how they had made their choice Many said that the sun shining into the van had provided a clue, some thought they knew the location and that they had followed their route on a memorised map The sunshine theory could be easily verified on overcast days, the results seemed to be the same both on sunny and on cloudy days

The experiment was repeated with 16 to 17-year-olds who were also given bar magnets which they could refer to when their blindfold was removed. Fifty per cent of the bar magnets were fake—brass bars of the same size as the real magnets. At five kilometres from the starting point and at a second point at the same distance but 90° away from the first position brass bar magnet holding students were more correct. Those wearing real magnets erred by 90° counter clockwise.

The experiment was repeated once again with the students wearing helmets with which the magnetic field through the head could be varied by means of Helmoltz coils connected to batteries. People wearing deactivated helmets were used as controls. This study and subsequent ones only added proof to their earlier studies that humans do perceive magnetism.

How does magnetism affect our daily lives? Can our magnetic sense be damaged and if it is damaged what are the repercussions? Scientists are trying to figure out answers to these questions.

BRAIN CANCER IN PETROLEUM WORKERS

The incidence of brain cancer in petrochemical workers it has been found recently is twice as high as that of the general population. This finding came to light when investigators of the National Institute of Occupational Safety and Health (NIOSH) followed up a complaint by an afflicted petrochemical worker.

Workers from two Texas (USA) companies Union Carbide the company where the ailing worker was employed and the Dow Chemical were screened. Only one of the 43 affected persons survived. What chemical(s) in petrochemicals is the tumour growth has not been pinpointed. Another study of three oil refineries (also in Texas) by the US National Cancer Institute has shown that the tumour formation rate is higher than normal not only in the brain but also in the stomach liver lungs pancreas and kin.

As a result of these findings the NIOSH is checking the health records of other groups of workers in the chemical petrochemical and pharmaceutical industries.

DID GALILEO SPOT NEPTUNE?

Galileo has been credited with several astronomical discoveries the major moons of Jupiter the rings of Saturn the mountains on the Moon the waxing and waning of the Venus and so on. Now another ardent Jovian moon finder Charles T. Kowal of the Palomar Observatory California Institute of Technology and Stillman Drake of the University of Toronto have found that Galileo Galilei had indeed noticed and noted Neptune in his records. Neptune was discovered in 1846 by John Galle.

Going through Galileo's records during 1612 1613 when Jupiter had passed in front of Neptune, they found that Galileo had indeed noticed it but had taken it for a star. How did he make such a mistake? Star maps in those days were not as well depicted as today naturally there were several blanks that have been filled in only much later.

According to the renowned astronomer's records a star was noted on 28 December 1612 and again on 28 January 1613. No bright stars are known to have been near the Jovian-Neptune conjunction in Virgo those years. The mean daily motion of Neptune being so small may have been a reason why Galileo failed to notice its movement. Through his telescope Neptune would have appeared just like a star.

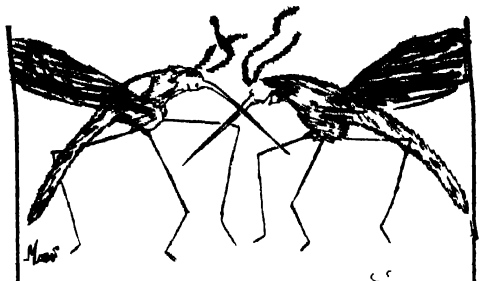
Since its discovery 134 years ago we have not seen Neptune through one full orbit yet and therefore astronomers are not familiar with perturbations if any in its orbit. The orbital period of Neptune equals 165 earth years. A comprehensive knowledge about its complete orbit would help in detecting if any planet exists beyond Pluto.

Another conjunction of Jupiter and Neptune had occurred in September 1702. Looking into the past astronomical records during the conjunction might show whether any other astronomer had noticed the planet. These records would help present day astronomers greatly in their calculations.

THE BITING HORMONE(S)

Female mosquitoes feed on plant juices for the first two or three days of their adult life. But without a blood meal the mosquito cannot reproduce. What induces the biting and blood feeding in the mosquito? R. W. Meola and R. S. Petralia of the Texas A & M University USA suggest that juvenile hormone may be one of the responsible factors at least in some mosquito species. During the period of plant juice diet the adult female initiates sexual behaviour and begins to develop ovarian follicles. Juvenile hormone (JH) is known to be responsible for the follicular development. Therefore the Texas entomologists investigated whether the withholding of JH would prevent biting. Surgical intervention to create JH deficiency they found inhibited biting in the two species *Culex pipiens* and *Culex quinquefasciatus* they studied. Replacement of JH however initiated the biting behaviour.

Since JH initiates ovarian follicular development the scientists reasoned biting could also be induced by ovarian hormones but ovarectomised mosquitoes behaved no differently from the intact control insects they found. Thus ovarian involvement was ruled out in these species. However, in the species



Looks like they're mixing up their favourite Freudian hyperboles with our right to enjoy sex in public

Aedes aegypti and *Anopheles freeborni* there seems to be some sort of ovarian involvement. Whether or not the ovarian hormones influence JH secretion in these cases is not yet clear. Armed with more knowledge about their biting behaviour we might be able to find a new way of controlling mosquito borne diseases such as malaria filariasis yellow fever encephalitis and dengue.

FLYING GIANT

The biggest bird alive now is the ostrich and it cannot do what most birds can that is fly. The largest flying bird today is the condor of the Americas. However when compared to the jumbo of the bird world these are mere pygmies. Two Argentinian paleontologists Eduardo Tonni and Rosendo Pascual have found the fossils of a giant flying bird. Weighing about 77.5 kg it measured 3.4 metres from the tip of its beak to its tail tip. Each wing measured about 1.2 metres and the largest wing feathers measuring 1.5 metres long were about 18 cm across. It stood 1.8 m tall and its wing spread was 7.5 m. It is said to have sailed the skies some eight to five million years ago.

Fossils of many types of extinct giant birds called teratorn by ornithologists have been excavated. This new specimen christened *Argentavis magnificens* represents a new genus of teratorns. It is related to the teratorns found in the La Brea tar pits in California USA. Teratorns according to the US National Geographic Society's paleontologist Kenneth Campbell are relatives of the present day storks and the New World vultures. The long narrow hooked beak and the type of jaw mechanism found in this species are similar to those that would be expected of a bird that grabbed small animals with its beak and swallowed them whole says Campbell. Their diet probably comprised mice, lizards snakes frogs nestlings and may be fish.

And as to whether such a large bird could fly Campbell has no doubts. Its entire anatomy suggests that it flew. It probably just spread its wings and waited for the wind to lift it off the ground. Upward thermal currents probably helped it to soar, much like the present-day vultures. It had the right kind of wing

such a well-equipped bird choose not to fly?

THE GENE THERAPY CONTROVERSY

Genetic engineering technology has now found its way to humans and kicked off a furore The experiments had not worked on animals but Martin J Cline and Winston Salser and a team of scientists from the University of California Los Angeles, (UCLA) USA, tried them out in humans Cline, who is both a molecular biologist and clinician, apparently thought the time was ripe for human experimentation But fellow scientists criticise that 'he (Cline) has made a conceptual leap from the failure in a model system to trying it in humans'

The UCLA Human Subjects Use Committee to whom the UCLA team submitted the proposal for the experiment on humans refused permission until further animal tests had been conducted However the University Polyclinic Naples Italy and the Hadassah Hospital Jerusalem Israel had given them the green signal Thus two terminally ill patients suffering from beta zero thalassemia were used for the experiments They were however told that the likehood of its working was very small The UCLA team took small amounts of bone marrow cells from the two patients suffering from beta thalassemia a fatal blood disease which is inherited and in which one of the protein components of hemoglobin molecule is missing They had genetically engineered cloned genes that could initiate the production of the proteins missing in thalassemia patients These genes were put into the bone marrow of the patients and the transferred marrow cells were returned to the patients Till now both patients are alive!

The main criticisms against Cline and Salser are that they have been too hasty and that the transplanted gene is incomplete Another view is that it is unethical for a scientist denied permission in his own country to seek permission in foreign countries Though the two scientists had permission from the hospitals, the public opinion is that they were taking undue risks Some of Cline's colleagues in the field feel that he (Cline) did it out of his desire to be the first to apply recombinant DNA technique in humans The incident, however, is likely to raise doubts in the public mind Can one trust scientists to be responsible, or will personal ambition overrule all other considerations?

Cline himself says that some of his critics are molecular biologists but not clinicians 'Molecular biologists are criticising a clinical experiment without really knowing its logic", he says, 'I realise that I was taking the risk of drawing criticism for such experiments But I don't know of anyone in the country who had precisely the same type of skills that I have, with knowledge both in the animal systems and in clinical investigations in man I think that in that sense I must be unique In the last analysis, one must ask how responsible an investigator has been up to that point in time'

WAS RUSSIA GIVEN A BAD NAME?

In the spring of 1979 in Sverdlovsk in the USSR, several people died of a mysterious disease (SCIENCE TODAY December 1979, p 19) When the reports crossed the national borders, the West jumped to the conclusion that the deaths were due to accident at a germ warfare lab Reconstruction from the news reports led Western analysts to believe that the Soviets were playing around with the deadly pulmonary anthrax germs However the scientists are now reconsidering their earlier opinion

What has led to the revision of the earlier opinion? A review of past Russian scientific literature together with a better understanding of the gastric form of the disease makes the Russian explanation seem more plausible Gastric anthrax which is quite rare in the West occurs on an average once in three years in the USSR Besides this disease has been reported to have caused 100 per cent fatality in an earlier epidemic in the Soviet Union Also, over vast regions of Sverdlovsk, the soil is infested with anthrax in a patchwork fashion Cattle probably pick it up from the fodder and when they develop the disease, peasants kill them and sell the meat in black market

Another factor backing the Soviet explanation is that in an outbreak of pulmonary anthrax all the deaths would occur in a brief span of two to three days But the deaths seem to have been more widespread time-wise

According to Soviet doctors, it is difficult to tell the difference between the gastric and the pulmonary form of the disease In fact, they even suggest dropping the distinction between the two and clubbing them both under the heading visceral anthrax In spite of the fact that Soviet experts (Ministry of Health) article on the outbreak appeared in May 1980 (in the Russian *Journal of Microbiology Immunology and Epidemiology*) and this could be taken as response to the American representations, the Sverdlovsk incident may have been just what the Russians said it was, the article it appears had been submitted for publication in August 1979

DID ANTIBIOTICS PROTECT THE ANCIENT AFRICANS?

Sudanese Nubians around 1400 years ago probably ate tetracycline without knowing it, the fluorescence patterns of their bones show Tetracyclines it is known, cause staining and fluorescence in calcifying tissue The intense yellow green phosphors produced persist through time and are often used in the analysis of bone dynamics Now L I Bassett M S Keith G J Armelagos and D L Martin of the University of Massachusetts Amherst USA and A R Villanueva of Henry Ford Hospital Michigan USA have found similar fluorescence characteristics in Nubian bones dating from 350 to 550 AD How could this be explained?

One explanation put forward was that the bones were probably infested by moulds after death However, since there was no damage noticed on the bones, this theory was discounted The other more plausible explanation is that the Nubians ate grain infested with the mould like bacteria called streptomycetes from which present-day non synthetic tetracyclines are produced This organism needs a very dry, warm and alkaline environment Under normal circumstances they comprise 60 to 70 per cent of the bacteria in the desert soil of Sudanese Nubia And ancient Nubians, the scientists hypothesise, stored their grain in mud bins and that is how they ingested the antibiotic They also isolated streptomycetes antibiotic behaviour showing from grains cultured at 55°C on soil samples collected from Sudan

How much antibiotic the Nubians ate has not yet been determined but the drug may have had broad implications on their health Tetracycline is a broad-spectrum antibiotic which attacks both gram-positive and gram-negative bacteria, rikettsiae, spirochaetes and certain viruses It also has an anti-malarial effect on humans It is quite likely that the drug had saved many an ancient Nubian life



Of vibrations, soldier's steps and galloping cables

S Suryanarayan

Vibrations can cause bridges to flutter and cables to dance themselves to failure

ON 7 NOVEMBER 1940, the Tacoma Narrows suspension bridge at Puget Sound, Washington (USA), snapped and collapsed with a resounding bang in a moderate wind of 19 metres per second The bridge, suspended on two steel cables, had absorbed energy from the wind and had used it to maintain and amplify its vibrations The bridge deck and road were moving up and down and also twisting around their axis for about an hour before finally collapsing

This is one of the more dramatic examples of how vibrations—of natural or man-made objects—can vitally affect our lives A machine in operation vibrates and may cause a nut or a bolt to come loose and bring production to a standstill A tall chimney may start swaying in a moderate wind and crack up A motor car passenger who has cheerfully withstood a fast car ride may throw up when the vehicle slows down over a long, rough stretch of road The anonymous culprit in all these cases is mechanical vibration

Vibrations are also characteristic of a large class of natural processes Leaves flutter and thin tall trees sway gracefully in a gentle breeze The buzz of the bees and the drone of the mosquito are generated by the to and fro motion of their wings at many hundred times a second Waves on the water surface make particles underneath oscillate When shaken by an earthquake or an underground explosion, the earth may vibrate at the rate of about one cycle per hour Our hearts beat and lungs expand and contract periodically Even as we say 'vibration' the lips and the tip of the tongue vibrate and our ear-drums vibrate as we hear it

Besides these vibrations in nature, man is concerned with vibration almost every moment in his life The swinging pendulum of old clocks and the crystal oscillations in modern digital watches provide him with a method of generating a unit for the measurement of time Vibrations provide him with enchanting music but can also irritate him in the form of noise. It pervades all industry, for the structural components of all machines with moving or rotating parts vibrate Motor cars and other vehicles shake pronouncedly while running over a rough road Mechanical vibrations can be harnessed usefully like in vibratory mixers, sieves, sorters, vibratory conveyors and drills They can also cause serious problems by breaking structural components, causing discomfort and damage to the human body, and causing malfunctioning of instruments

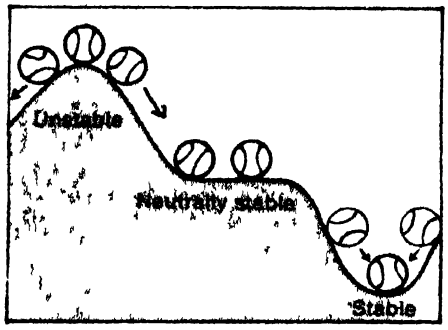


Fig 1 Only stable systems vibrate If given a displacement a system in unstable equilibrium will move away from the equilibrium position a system in neutral equilibrium will remain in the new position only a stable system will experience a *restoring* force which will make the system return to its equilibrium position

The vibration of mechanical systems forms an important field of study for physicists and engineers The physicists look for answers to questions like what is vibration? How can the basic phenomenon be represented mathematically? How is mechanical vibration related to phenomena like propagation of sound? The engineer starts from the answers and further asks how vibration can be prevented, controlled, damped, isolated, generated, amplified, measured and analysed How can it be used effectively and its harmful effects minimised? We shall for the present be concerned with understanding the phenomenon of vibration and its effects

Vibration is a very general concept Any quantity that fluctuates can be considered to be vibrating According to the nature of the quantity that fluctuates, vibrations can be optical, electrical, electromagnetic and so on When they involve variation with time of displacement, velocity or acceleration, they are called mechanical vibrations All wave motions in solids, liquids or gases involving particulate motion, including sound waves are mechanical vibrations We shall however be more concerned with mechanical vibration in solids

One tends to think of vibration as regular and periodic That is not necessarily so Many vibrations are random and except for the fact that they fluctuate around a mean value and within a certain range, none of the patterns of fluctuations need be regularly repeated Periodic vibrations,

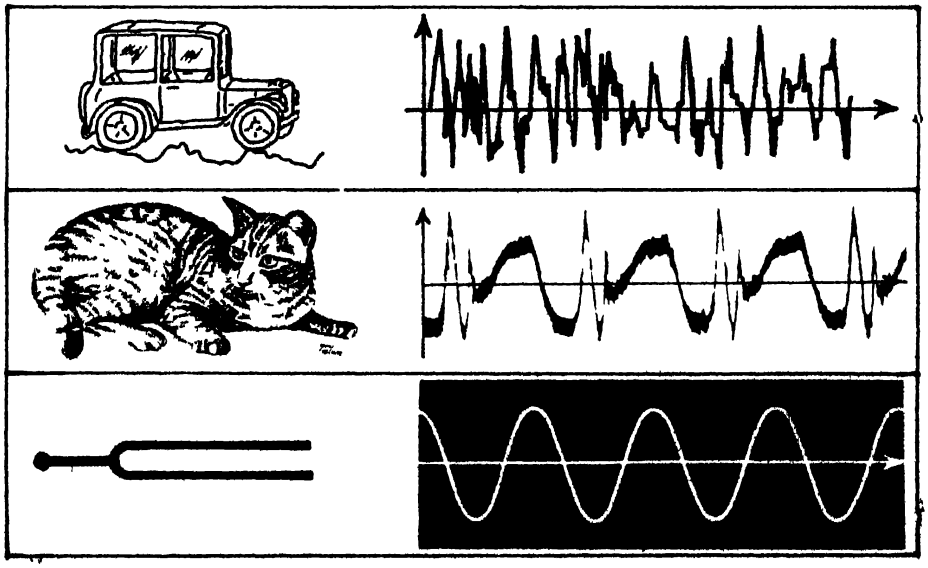
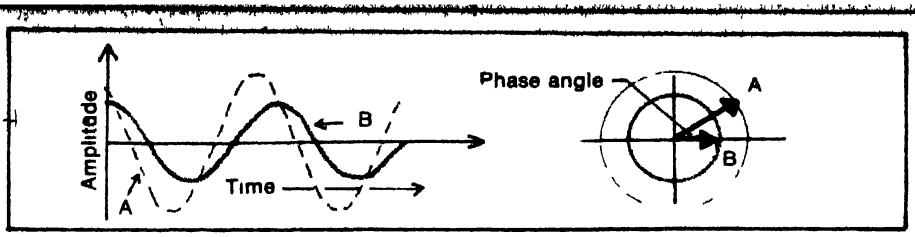


Fig.2 Vibration can be of many kinds At the top is shown a random vibration which for example could be encountered by a car on a bumpy road In the middle is shown a periodic vibration in this case the pressure variations inside the heart of a cat At bottom is shown a regular sinusoidal simple harmonic vibration like that of a pendulum or a tuning fork



Sinusoidal vibration represented by a rotating vector The vertical components of the vectors represent the vibrating quantities The angle between the two rotating vectors at any instant is the phase angle The two vibrating quantities A and B have different amplitudes but because they have the same frequency, they have a constant phase angle

Free or natural vibration

FREE VIBRATION is a characteristic of stable systems A stable system when disturbed from its equilibrium position tries to return to it When disturbed and left to itself, it generates forces proportional to the amount of displacement from the mean (equilibrium) position which try to restore it back to the initial equilibrium position In the case of a pendulum or a ball in a valley-shaped groove gravity provides these forces When this displacement involves deformation of solid structures (like stretching a rubber string compressing a spring or on a grander scale vibrating aircraft and suspension bridges) the restoring forces are provided by the internal reactions produced by the elasticity of the material

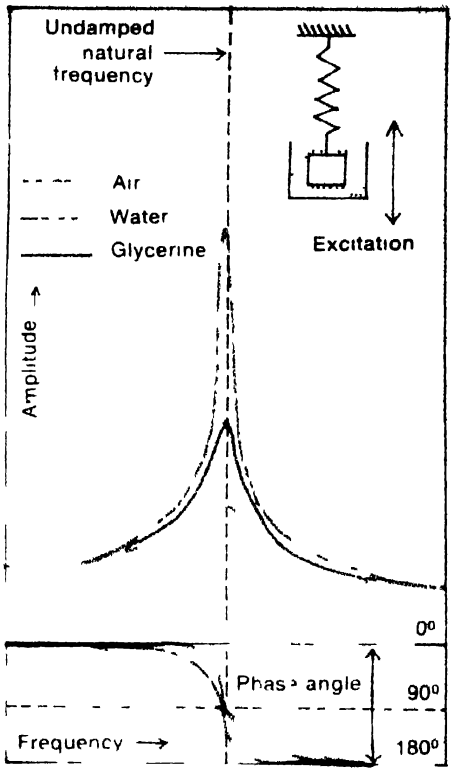
But if things simply came back to their equilibrium positions there would be no vibrations Actually the initial displacement of a system from its equilibrium position imparts a definite amount of potential energy to the system By the time it reaches the equilibrium position this potential energy appears as kinetic energy so that the masses in the system are moving when the system reaches it equilibrium position and this causes the system to overshoot With a displacement by overshooting the whole story starts over again until loss of energy through friction and other damping mechanisms finally brings the system back to rest at the equilibrium position Such oscillatory motion is called free or natural vibration In principle, the phenomenon that underlies the free oscillation of a simple pendulum or of an aircraft in motion is the same

When the stable system oscillates with small amplitudes the restoring forces can be considered to be linearly proportional to the displacement and the vibrations can be represented by a sinusoidal variation of displacement with time Such periodic vibrations can be represented by projections of rotating vectors (see figure above)

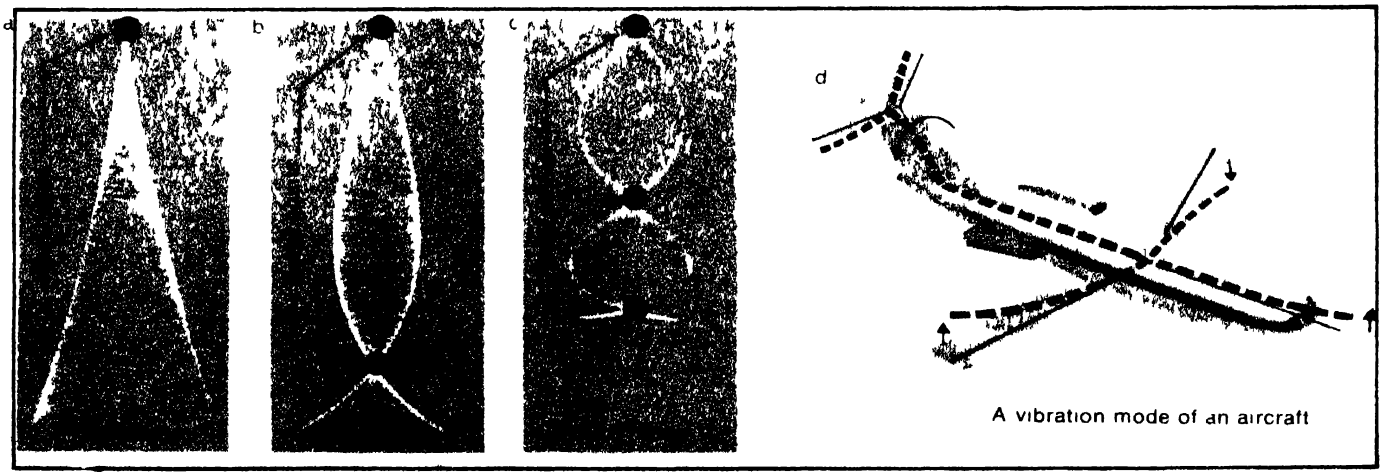
The period or frequency of natural vibration is an important characteristic of a vibrating system It depends on the strength of the restoring action and the masses in the system A system can have one or more natural frequencies according to the characteristic shapes it can assume during vibration (see figure below) A stretched string or chain can have an infinite number of natural frequencies

Theoretically, a stable system, once set in motion would keep on vibrating indefinitely at one of its natural frequencies In practice these natural vibrations (at the macro-level and not at the micro-level or the molecular level) die down with time as their vibrating energy is dissipated This is called damping Friction, viscosity and plastic flow are some of the mechanisms by which damping occurs and keeps the world more or less stable

S S



Damping plays a key role in resonance Imagine a weight suspended by a spring and being forced to vibrate in air,water and glycerine Glycerine being most viscous, will absorb most energy and show largest damping the amplitude at resonance will be smallest in glycerine and largest in air However,the phase angle at the undamped natural frequency will be 90 degrees irrespective of the amount of damping



A vibration mode of an aircraft

Aircraft shapes undergo vibratory deformation A system resonates at as many natural frequencies as the number of modes of its independent deformation shapes The first three modes of vibration of a vertical chain with its upper end fixed are shown at a,b c respectively Aircraft in motion are perpetually vibrating at many of their natural frequencies A typical deformation shape the first antisymmetric mode is shown at d

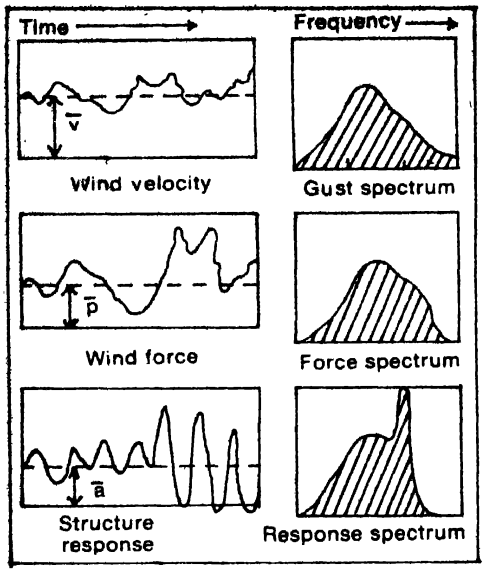
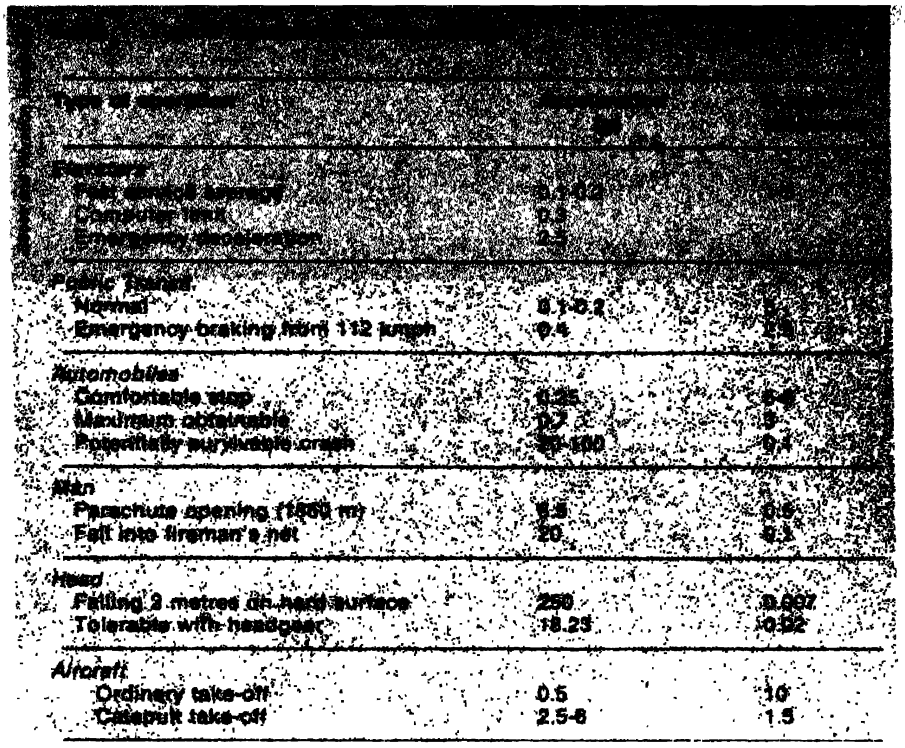


Fig.3 Complicated vibrations may also be represented as power spectrums. The wind velocity, wind force and the response of a structure to wind excitation are shown at left as a variation of amplitude with time and, at right, as a variation of power level with frequency The peak in the response spectrum is closer to the natural frequency



which repeat themselves after definite intervals of time are a more familiar class. The smooth sinusoidal or harmonic vibrations form a class by themselves.

Forced vibrations, resonance and marching soldiers

A system may vibrate of its own accord or it may be forced to vibrate. Free vibrations of a system occur at a set of preferred frequencies called natural frequencies of the system (see box on page 17). When a system is forced to vibrate or is excited by an external force varying periodically with time it undergoes forced vibration. It vibrates in response at the frequency of the external source which is then called the forcing frequency.

Soldiers marching in step will force a bridge to vibrate. If the natural frequency of the bridge is close to the marching frequency large amplitude oscillation might result. Legend has it that a column of Napoleon's armies had caused a bridge to collapse in this way. When the forcing frequency coincides with one of the natural frequencies of a system, the amplitude of vibration can become very large and it is said to resonate. Soldiers now take resonance in their stride by breaking step while crossing a bridge.

Theoretically, at resonance the amplitude of vibration would tend to become infinite but for damping. There will also be a phase difference (see box on page 17) between the excitation and the response. Resonance, when under control, can give us mellifluous music. Unwanted resonance, however, can prove to be disastrous at worst and is annoying at its very best, so that its control is a serious matter for the engineer.

So far we have talked about a single forcing frequency. Very often, however, the imposed vibration does not have a single frequency. Such is the case when a motor car runs over a rough road (the random variation of Fig. 2). The imposed vibrations in such cases are not periodic but random and their analysis has to be handled differently. It is then generally more convenient to represent such vibrations as a combination of harmonic excitation at various frequencies. The power level of vibration at various frequencies of excitation, known as the power spectrum, can conveniently characterise the imposed vibration in such cases. The response of a system subjected to such vibration is then represented as a vibration of the amplitude or power level with frequency and is known as the response spectrum. The curves show peaks at certain frequencies. The peak levels in the response spectrum of a structure will not be at the same frequencies as those for the power spectrum of the imposed vibration. Response spectrums generally show peaks closer to the natural frequencies, indicating that structures absorb energy more efficiently near their natural frequencies.

There are situations when a mechanical system is forced to vibrate by an external force whose variation with time is neither periodic nor random. It may vary in a known manner, but not periodically. The external force is then said to be a-periodic and deterministic. This is the case when a hammer strikes a structure or when a gong or a drum is struck. Excitation by such a short-duration force pulse (mechanical shock) causes a transient vibration as against the steady-state vibration generated by continuous excitation. Transients last only for a short duration and die down with time because of the inherent damping in the system. These vibrations are also encountered daily in engineering practice. Because of the large amplitudes they sometimes attain, it is necessary to find

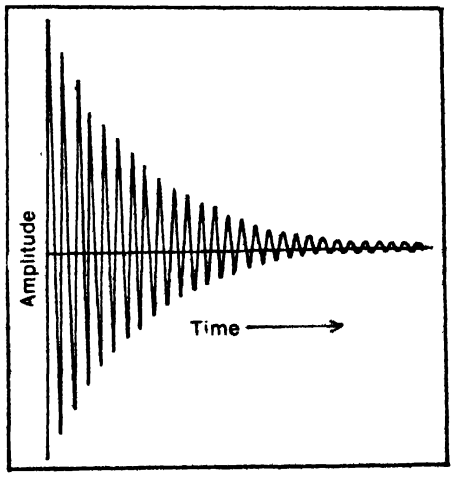


Fig.4 Transient vibration. Damped motion of a gong struck by a hammer

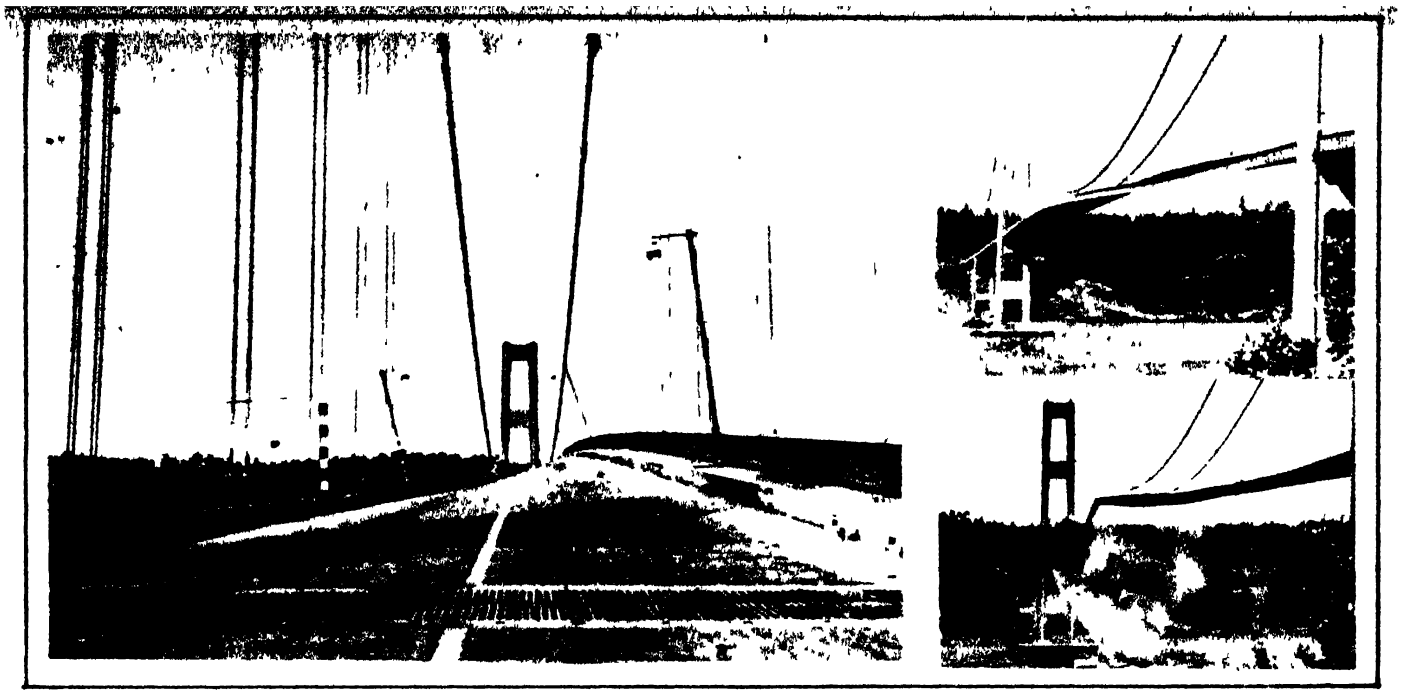


Fig.5 The bridge that vibrations broke The Tacoma Bridge broke down due to self-excited oscillations On the fateful day the bridge started vibrating up and down and also twisting about the central axis along the road length The photograph at left shows the twisted roadway The up and down movement of the span and the twist can be seen more clearly at top right while bottom right shows the actual failure

out whether they cause critical conditions.

Self-excited oscillations

In most of the above cases, the external source of vibration can be clearly marked out as separate from the system. Many systems appear to vibrate on their own accord without any external source of excitation. Such systems have a source of energy associated with them. Aircraft wings flutter above certain critical speeds, hose pipes oscillate when water jets out of them and rotating shafts whirl about their axes. These cases are known as self-excited vibrations (or oscillations).

When such a system vibrates it generates oscillating forces due to its inherent mechanism and these forces, in turn, sustain the vibrations. So we may say that the system excites itself. Suspension bridges and transmission wires are quite susceptible to self-excited vibrations.

A bridge excites itself to failure

A dramatic example of the harmful effects of vibration and one of the greatest catastrophes in the history of bridge building is the collapse in 1940 of the Tacoma Narrows Bridge over the Tacoma river mentioned earlier. The middle span of the Tacoma bridge spanned nearly 0.85 km and the 12 metre wide roadway was suspended on two steel cables 44 cm in diameter with a sag of about 71 metres. Soon after the construction of the bridge was completed it was found that it was very sensitive to wind and vibrated with amplitudes of the order of one and a half metres.

Even though the bridge was designed for a wind velocity of 50 metres per second under static loading, the bridge actually failed on 7 November 1940 at a wind velocity of only 19 metres per second. Just before failure the bridge was vibrating at around 0.2 cycle per second. The deformed shape which the Tacoma bridge assumed during these vibrations is what is known as a single node flexural-torsional mode. This means that the bridge deck and road were moving up and down (flexural) and also that it was twisting around the road length (torsional). When the twisting was maximum the roadway was inclined to the horizontal by about 45°!

The bridge failed because of the large amplitude self-excited oscillation. These oscillations absorbed energy from the wind and utilised it to maintain and amplify the vibration—a phenomenon known as stall flutter. Stall flutter is also a problem in the propeller blades of aircraft and the blades of compressors and turbines.

Most of the suspension bridge failures prior to the failure of the Tacoma bridge had taken place much earlier. The Laroche Bernard bridge in France with a span of 196 metres failed in 1852. It was rebuilt in 1871, only to collapse once more. A bridge with a span of 336 metres over the river Ohio in the USA failed in 1854. Suspension bridges with spans of 320 and 386 metres over the famous Niagara river failed in 1864 and 1889. The more recently constructed suspension bridges have been more successful.

Shimmying wheels and galloping cables

A form of self-excited oscillations, called shimmying, affects flexibly mounted wheels which wobble when the speed is increased beyond a critical value. The problem sometimes also affects vehicles and their wheels wobble because of self-excited vibration generated by friction between the wheels and the road. The undercarriage of aircraft can give trouble when the nose-wheel has shimmying problems and could even lead to disaster (Fig. 8).

Electric transmission lines slung between pylons can oscillate with large amplitudes under certain weather conditions. This problem is more common in areas that receive generous snowfall. The ice that forms on the lines or cables changes the cross-section from a circular one to a shape like an airfoil (Fig. 7 on page 22) capable of generating lift (a force normal to the wind direction). When wind velocity reaches a critical value the transmission lines absorb energy from the wind stream and start oscillating violently. This oscillating motion of the cables, which may con-

Vibrations and the human body

THE HUMAN body is affected by vibrations, and sometimes even beneficially Children can be rocked to sleep and music soothes the nerves Even if the rattling of a motorbike or a car annoys the adults, children will promptly go to sleep But with industrialisation, it is the harmful effects and their control which become important

The human body can withstand large displacements and velocities pretty comfortably, but large changes in velocity, that is, acceleration affect it most Just as vibrations involve displacements varying with time, they also imply velocities and accelerations changing with time The human body may withstand a steady acceleration of up to many times the acceleration of gravity for short durations without damage, but it is very susceptible to cyclic variation of acceleration A *cyclic* acceleration of as low as 0 3 g may prove damaging

Acceleration amplitudes are related to displacement amplitudes in a vibratory system The larger the vibratory displacement, the higher the accelerations for the same frequency, the larger the frequency of vibration, the larger the accelerations in a vibrating system for the same displacements For sinusoidal vibrations the acceleration is proportional to the displacement amplitude and the square of the frequency Accelerations are thus more sensitive to changes in frequency than to changes of displacement amplitudes

Body vibes

So far as vibration is concerned a human being is made up of a number of mechanical systems each with its own natural frequency The natural frequency depends on the mass of the organic system and the stiffness of the muscles and the tissue supporting it The response of various parts of the human body is thus not uniform for all frequencies However, the body is more sensitive to vibration in the range of one to 80 cycles per second (cps)

The subjective response to vibration varies from the bare threshold of perception to varying degrees of discomfort and finally pain and damage This response is roughly mapped out in the figure below The response is shown in terms of frequency and amplitude for convenience, but the actual parameter is acceleration which is a compound effect of both The body seems to be *more* sensitive to lower amplitudes at higher frequencies but this is simply because at high frequencies low amplitudes can generate the requisite acceleration Actually, at frequencies over 80 cycles per second the body begins to be *less* sensitive to vibration

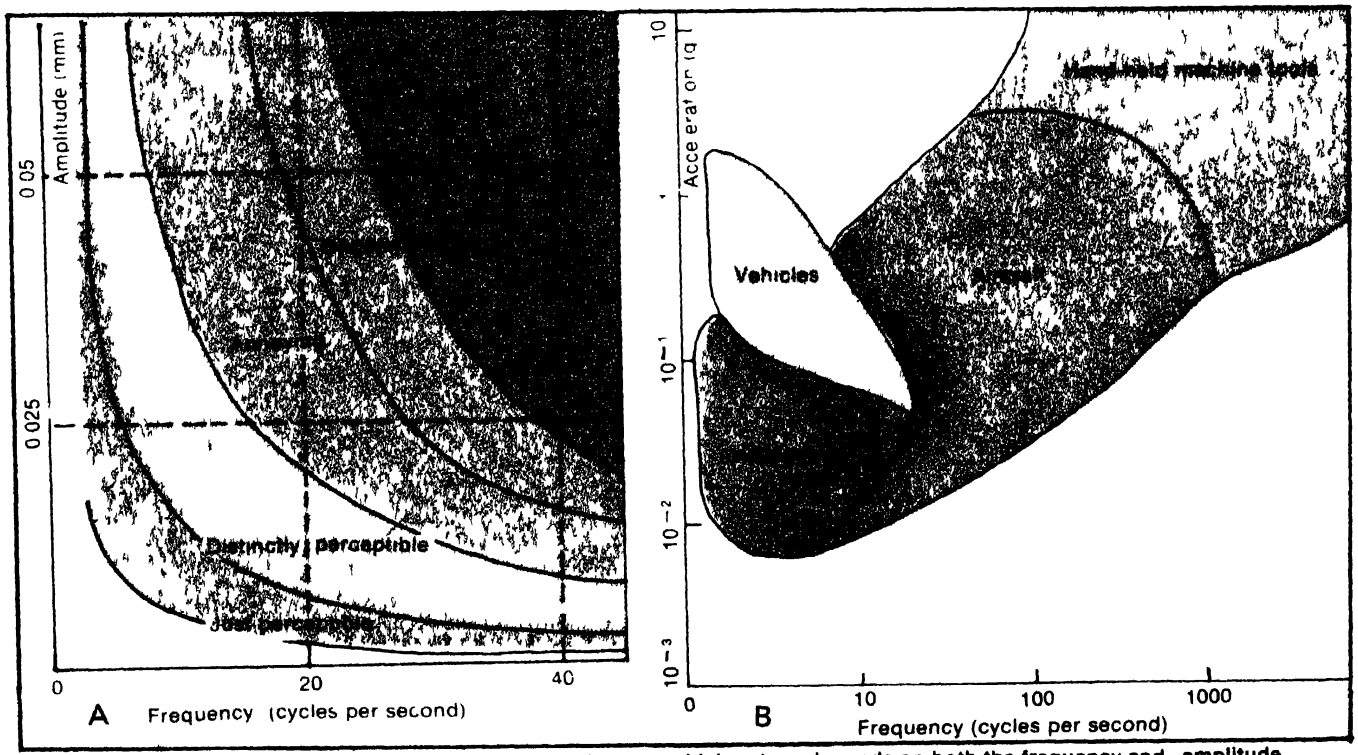
Vibrate slowly and be sick

Besides the level of acceleration and frequency, the response also depends on the posture as well as the duration of exposure The response to vibration at the same frequency could be different for a vertical acceleration imposed on a *standing* human being and a horizontal acceleration applied in a *sitting* position The response, especially the onset of pain, also varies somewhat from person to person Nevertheless, abdominal pain and chest pain seem to be the main effects of vibrations in the range of four to ten cycles per second and dyspnoea stands out as the major effect (see Table)

Passengers in ocean-liners are bothered by *sea sickness* caused by the low frequency oscillations of the ship The waves on the water surface usually induce the ship to rock and roll at very low frequencies The passengers in the tourist class, situated near the bow are especially bothered by this problem because of the larger amplitudes First class passengers in cabins situated near the middle of the ship experience lower amplitudes though at the same frequency Thus, according to Prof Bishop, the human body prefers smaller amplitudes (and first class travel) !

Vibrating skulls, blurred vision, ...

At frequencies above 80 cycles per second though the sensitivity of the human body is reduced, large acceleration levels will still continue to cause problems Some of the sub systems of the body resonate *above* 80 cycles per second The lower jaw resonates in the



Tolerable levels of vibration Tolerance depends on acceleration which in turn depends on both the frequency and amplitude A tolerance map of vibration is shown at A in terms of amplitude and frequency Various sources of excitation and their corresponding approximate range of maximum accelerations are shown at B

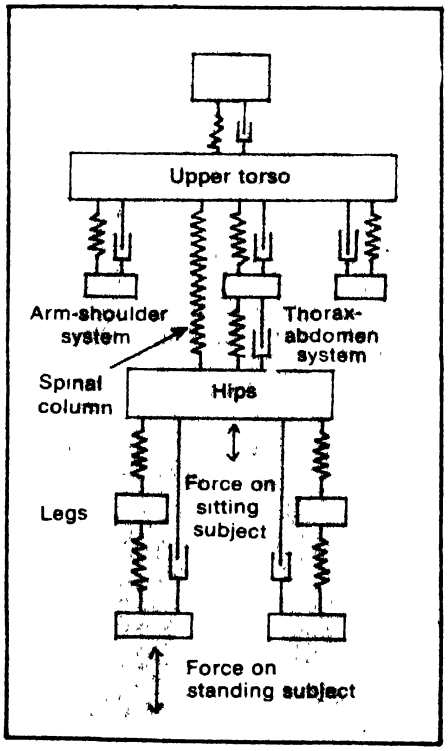
Table : Subjective responses to low frequency vibration

Symptom* / Frequency	Abdominal pain	Chest pain	Testicular pain	Head symptoms	Dyspnoea	Anxiety
1 cps					xxxxxxxx	
2 cps					xxxxxxxx	
3 cps	xx	xx			xxxxx	x
4 cps	xx	xx		xx	xxx	xx
5 cps		xxxx				x
6 cps	xxx	xxxx		x		
7 cps	xx	xxxxx	x	x		
8 cps	x	xxx		x		xx
9 cps	xx	xxxx			x	
10 cps	x	x	xxx	xx		x

* Subjective responses of a sample of ten persons. The crosses indicate number of persons reporting the symptom General discomfort was reported at all frequencies

range of 100 to 200 cycles per second. The skull vibrates at the fundamental frequency of around 300 to 400 cycles per second.

Physical response to vibration involves body displacements, velocities and accelerations. It can cause mechanical interference in the performance of tasks and in serious cases can cause injury and mechanical damage to internal organs. Pilots of high-speed military aircraft may experience difficulty in performing manoeuvres in combat if the vibration level in the cockpit is very high. Blurred vision and hand vibrations are a serious interference in reading of displays and the operation of aircraft and armaments control



Vibration engineer's view of the human body. For the sake of vibration analysis the human body is considered to be a combination of various spring-mass systems with dampers

... fear and anxiety

Physiological responses include changes like in pressures, respiration and heart and brain potentials. The mechanical stresses generated by vibratory motion excite the nervous system and hormonal activity, modifying the metabolic processes relating to factors like food assimilation and muscular activity. The result is most often fatigue, reduction in the capacity to work and loss of attentiveness. Acute stimulation of the brain centres may even produce emotional reactions like fear and anxiety. The psychological response will finally play an important role in arriving at the subjective responses

Levels of vibration which produce no apparent acute effects for short durations may produce chronic injuries with long exposures. The shaking of heavy vehicles on rough surfaces involves such long exposures and persons exposed to these conditions show chronic minor injuries. Truck and tractor drivers often experience strain of the sacro-iliac joint (at the seat of the backbone) and, occasionally, minor kidney injuries. Localised vibration can also cause minor chronic injuries. Workers working with hand-held machine tools like pneumatic hammers and drills, grinders, polishers and chain saws may experience pain and numbing after several months of continuous exposure. The gradual degradation of vascular and nervous tissues leads to the loss of feeling and manipulative ability of the fingers known as the "white finger" syndrome.

S.S.

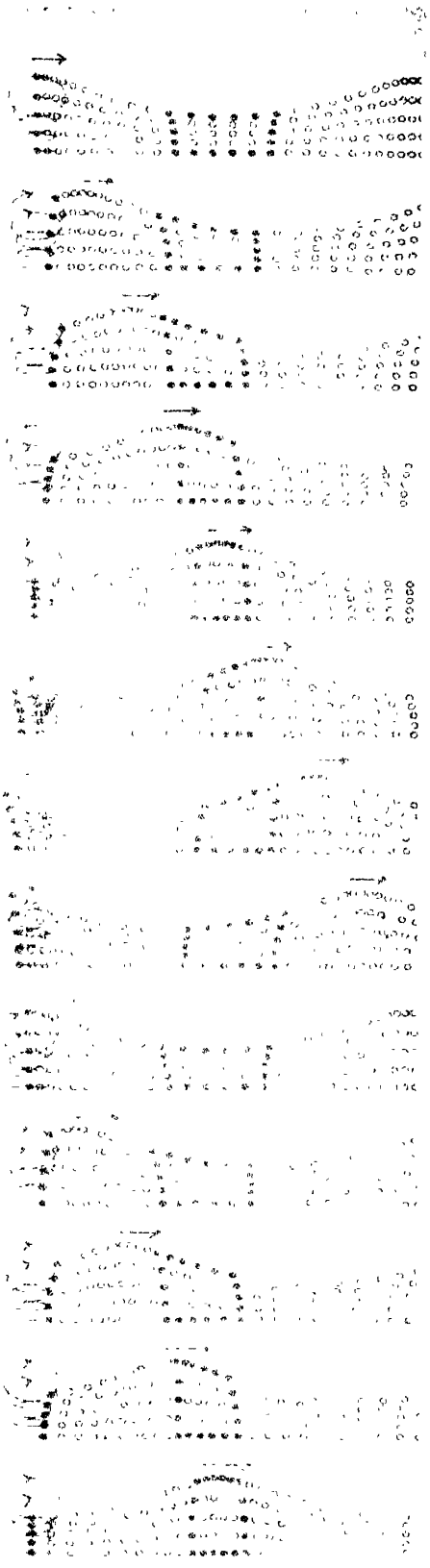


Fig-6 Surface wave on water. The particles of water trace out elliptical paths and the wave moves on the surface. These elliptical orbits decrease in size as we go deeper. In the sequence, the water particles trace clockwise paths and the travelling wave moves from left to right. A cycle is completed in a sequence of eight pictures. Solid dots represent the positions of the same particles throughout the sequence

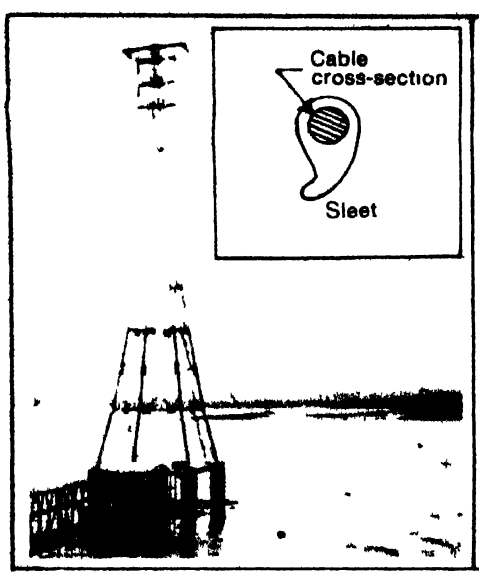


Fig 7 Galloping cables Heavy snowfall and sleet change the cross-section of cables slung between transmission towers Under certain wind conditions they can begin to oscillate violently This galloping may sometimes continue for as much as 24 hours



Fig 8 Shimmying disaster An aircraft crashes on landing due to the shimmying motion of landing gear Picture shows zig zag marks left by shimmying nose wheel

tinue indefinitely, is known aptly as galloping It involves both up and down vertical motion and twisting about its cross-sectional axis Galloping is known to have caused a number of cases of transmission lines hitting each other or breaking down altogether

Structures get tired too

Self-excited oscillations provide striking examples of the harmful effects of vibration Yet the more frequent cause of vibration-induced failure is' fatigue' Everyone knows that it is difficult to break a wire by pulling it But bend and straighten it alternately a number of times and it will eventually break easily The alternating load required to break a metal rod (its fatigue strength) is much less than a gradually applied load necessary to break it (static strength) Structures made of metals like aluminium may break at almost any load or stress level by alternatmg this a sufficient number of times Within limits, smaller stress levels need a larger number of cycles to break a structure than high stress levels It is the deformed shape associated with the vibration of the structure, machine or vehicle when forced to vibrate, which imposes alternating stresses on it varying with time at the imposed frequency of vibration The magnitude of the stresses is proportional to the amplitude of vibration A structure vibrating at 300 cycles per second completes more than a million cycles in an hour! Such loads, if not under control, are quite capable of causing materials and structures to fail by sheer fatigue

Aircraft structural components are heavily stressed and subject to stress fluctuations caused by dynamic loads during flight Of particular concern is fatigue-failure in the gas-turbine blades of jet engines The rotor of an aircraft gas-turbine rotates at about 10,000 rpm Air rushing onto the rotating compressor blades may excite them at one or more of their natural frequencies A combination of stress levels and cyclic stresses can produce fatigue-failure and a broken blade is the result Pieces of the broken blade blown into the engine may damage subsequent stages of the turbine and the entire jet engine is rendered inoperable

Fatigue-failure is also a problem in rail and road vehicles Before the Second World War, failure of crankshafts of engines was a very common occurrence With improvement in design there are fewer failures now But even now, engine components like valves and shafts are still known to fail in fatigue after long terms of service

An ubiquitous problem

Problems of vibration and fatigue have now been recognised as important by major industries like manufacturing, ship-building, chemical and construction industries Miles and miles of pipelines carrying liquids and gases at cryogenic to high temperatures for the petrochemicals industry, fuel rods in nuclear reactors and off-shore drilling platforms, all face fatigue problems Even smoke stacks, submarine periscopes and common TV antennae are vulnerable

Vibration also causes malfunctioning of equipment Malfunctioning of electronic devices in aircraft, missiles and spacecraft can seriously hamper their mission objectives Traffic on nearby roads and vibrating machines in the vicinity can affect precision machines and instruments In machine tools it causes a deterioration in the quality of surface finish and tolerances which can affect fastenings and precision components such as gears

The vibration engineer is concerned with devising methods of controlling and isolating vibrations by qualifying equipment for special purpose environments and analysing vibrations in machines and structures to monitor their condition All these are efforts to solve the ubiquitous problem posed by vibration and forms a separate sphere of study Sudden failures of bridges aircraft and many other structures have now proved that vibration is an important phenomenon and has to be seriously considered in designing safe and durable structures

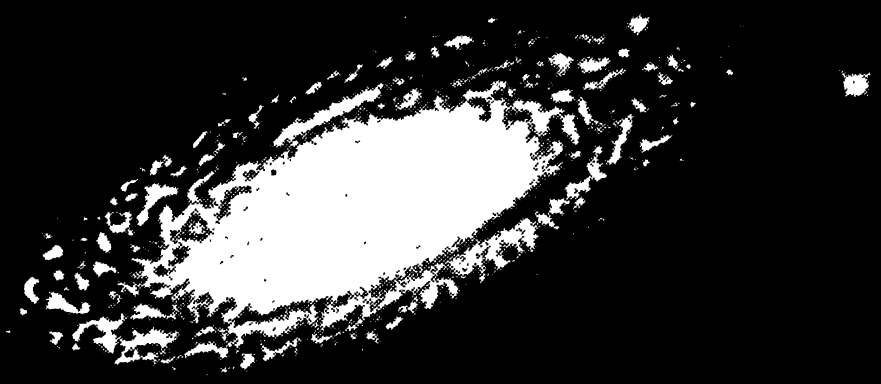


Dr Suryanarayan who obtained his Ph D from the Indian Institute of Science Bangalore is Assistant Professor in the Department of Aeronautical Engineering Indian Institute of Technology Bombay His major research areas are structural dynamics vibration engineering and aircraft structures

Recommends reading

1 *Vibrations and Waves in Physics* Irain A Main Cambridge University Press 1978 2. *Vibrations and Waves* A P French M I T Introductory Physics Series Arnold-Heinemann India New Delhi 1971 3. *Vibration* R E D Bishop Cambridge University Press 1965 4. *Shock and Vibration Handbook*, Ed Cyril M Harris and Charles E Crede McGraw-Hill Book Company 2nd Edition, 1976

FROM THE INFINITE



Distant Galactic System

TO THE INFINITISIMAL



Compound Eye of a Mosquito

A CARL ZEISS INSTRUMENT CAN PUT YOUR OBJECT IN FOCUS.

From the macro world of distant galaxies to the micro world of viruses and bacteria Carl Zeiss instruments probe the universe through the optical window. A spectrum that spans spectroscopy, microscopy, metrology, micro electronics, photogrammetry, survey, astronomy, medical science, microfilming, optics, planetaria, ophthalmology.

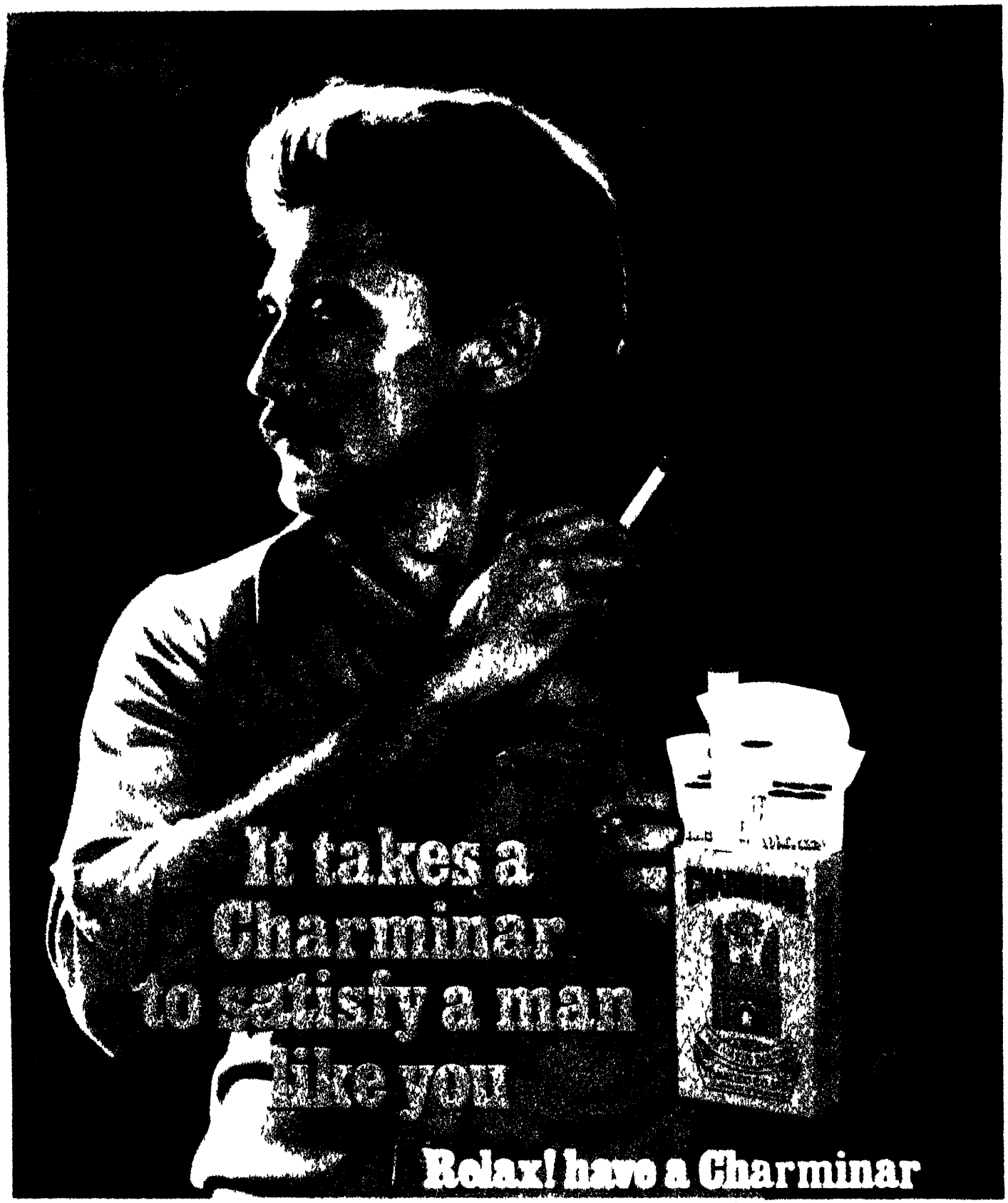
VEB
Carl
Zeiss
JENA
GDR

CARL ZEISS
JENA



Creative Unit 4683

SCIENCE TODAY, DECEMBER 1980



STATUTORY WARNING CIGARETTE SMOKING IS INJURIOUS TO HEALTH

CASVS 238-254

Re.1* for 10

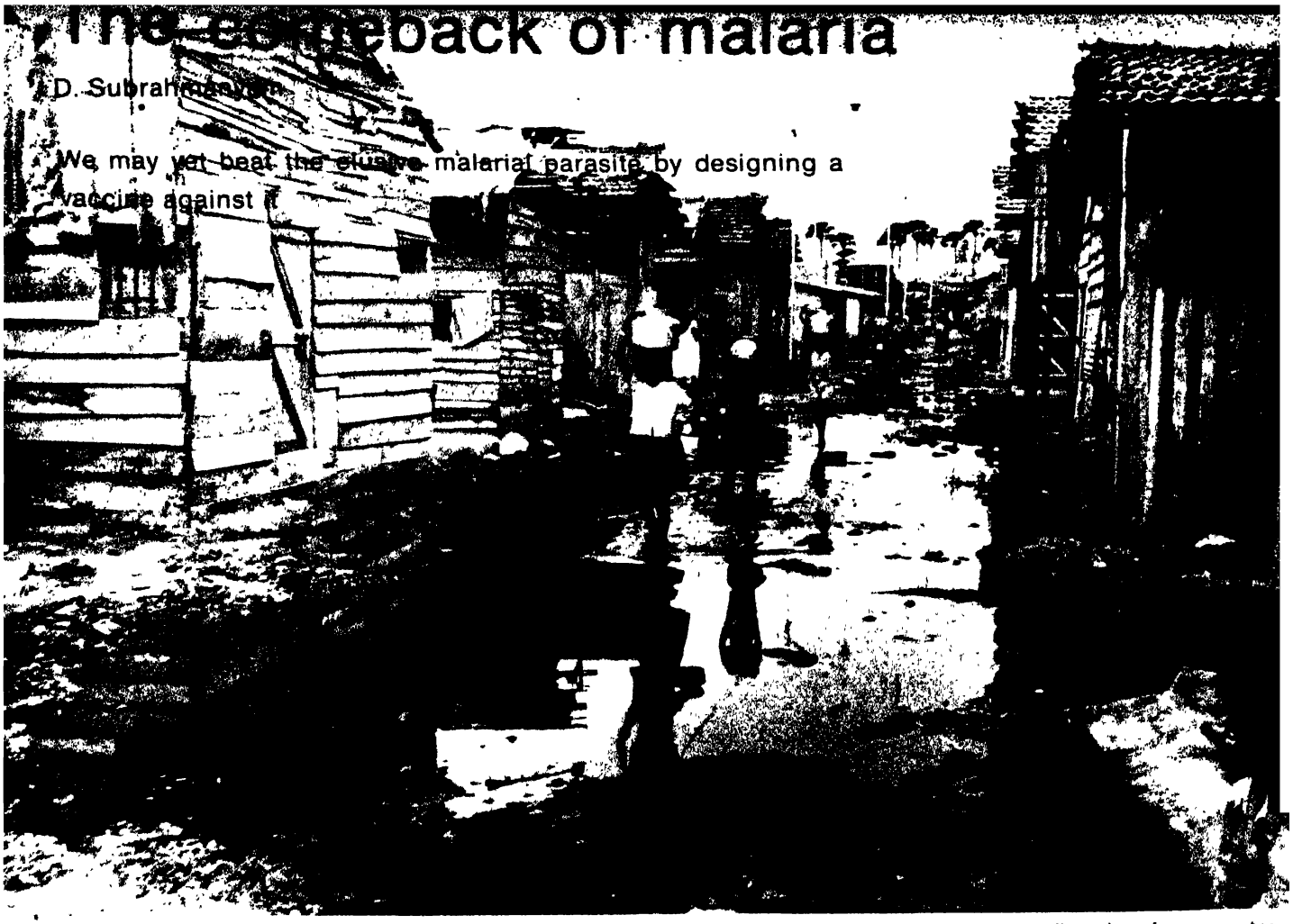
* Max Price Subject to Local Taxes

Main Dealer —**THOTA SATYANARAYANA & SONS, RAJAHMUNDRY**

The comeback of malaria

D. Subrahmanyam

We may yet beat the elusive malarial parasite by designing a vaccine against it



Stagnant water, a common sight, is a favourite breeding place for mosquitos

MALARIA, the ace killer among parasitic diseases, has now staged a come-back in most parts of the world. There are many reasons for its reappearance. For example, the conventional drugs used against the parasite are exhibiting their ineffectiveness. The anopheline mosquito which transmits the parasite to man not only shrugs off the DDT which has been the main weapon in the anti-malaria campaign, but it has changed its behaviour, rendering many of the anti-malarial measures ineffective. Hence, the thinking of public health authorities has shifted from eradicating the disease to containing it.

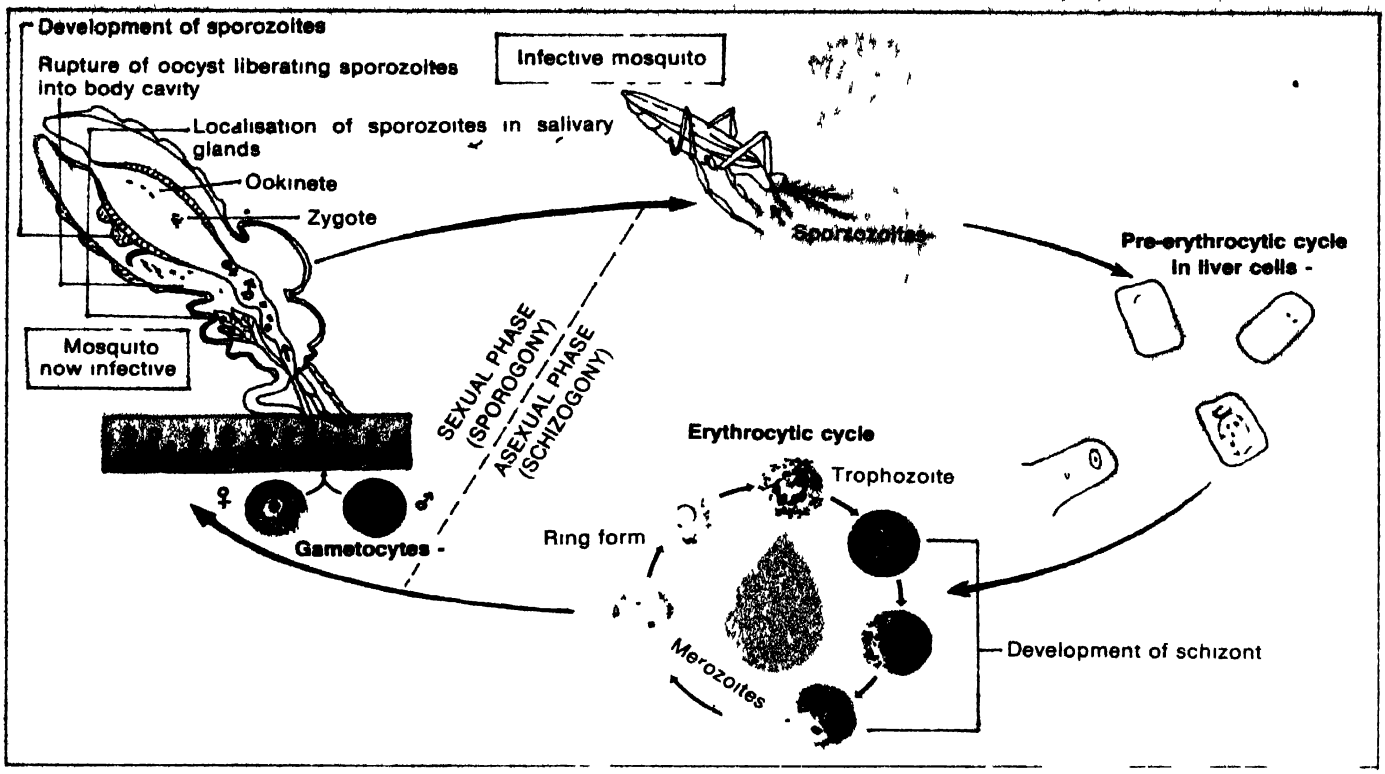
Malaria is also one of the most widespread of parasite diseases, occurring or having occurred in all continents, from latitudes 60°N and 40°S. Of a total of 2,015 million people living in areas where malaria has been or is still endemic, some 343 million, mostly in Africa, are not protected by any specific anti-malarial measures. In India, 250 million live in areas with a high risk of malaria and another 250 million in areas of moderate risk. Throughout the world, there are some 150 million clinical cases annually.

Even the socio-economic development in most tropical and subtropical areas of the world suffers because of malaria. Apart from the morbidity and deaths due to the disease, infection with a particular strain (*P. malariae*) is life long and leads to deaths from other causes and lowered vitality. Being predominantly a rural disease, it hits the farming community when they are most busy in the fields during the planting, sowing or harvesting seasons. A telling instance of the way in which malaria can affect the rural community occurred in the early fifties in the Gezira irrigated area of the Sudan; most of the labour force was struck by malaria and one-third of the cotton crop was left unharvested, causing a loss of more than US $10 million. It is estimated that malaria control would have cost just one-hundredth of the amount.

The organism causing human malaria, *Plasmodium*, is a protozoan—a single celled animal like the amoeba. It belongs to the class Sporozoa (sub-class Haemosporidia). Only four species, that is, *P. falciparum, P. vivax, P. ovale* and *P. malariae* use man as a definitive host. The severest forms of malaria are caused by *P. falciparum*, while *P. vivax* and *P. ovale* produce malaria of less severity which is rarely fatal. Malaria due to *P. malariae*, while clinically less severe, is more persistent. *P. falciparum* has a high fatality rate in non-immune or insufficiently immune individuals, which in endemic areas means mostly infants, young children and pregnant mothers. *P. vivax* causes the large majority of cases in India (70 to 80 per cent).

When the infection is by *P. vivax*, or *P. falciparum* the patient gets fever every 48 hours; in *P. malariae* infection, the fever comes on every 72 hours in the form of a sudden chill followed by a sensation of heat and sweating. *P. falciparum* malaria is more malignant, affecting the brain and causing death. This infection may result in black-water fever, where the breakdown of red-blood cells results in dark-coloured urine

Malaria has been known since antiquity; it has been described in Egyptian literature as far back as 1550 BC, but its cause was a mystery until the 19th century. The disease was thought to be caused by the foul gases



emanating from marshes—hence, its name derived from Italian *mal aria* which means bad air In 1880, Alphonse Laveran, a French scientist working in Algeria discovered that malaria was caused by a protozoan parasite Ronald Ross working on avian malaria in Calcutta, in 1877, found out the role of the mosquito in transmitting the disease This epoch-making discovery about the malaria vector later won him the Nobel Prize Soon afterwards, three Italian scientists B Grassi, A Bignami and G Bastianelli, reported that it was the anopheline mosquito which is the vector for human malaria and they described the cycle of development of the parasite in the mosquito Then, after a gap of nearly 50 years H E. Short in 1948 reported the role of the liver cells (hepatocytes) in the development of the parasite and thus filled in the blank spots in the life-cycle of the malaria parasite

Life-cycle

The parasite has a sexual phase and an asexual phase The sexual phase is completed in the female anopheles mosquito which requires a blood meal in order to reproduce (the male lives on plant juices) Only the female has the biting mouth parts required to suck blood When it bites a human, the infective form of the parasite—minute, thread-like organisms, 11-12 µ long called sporozoites—escape into the blood stream This initiates the asexual, schizogony or multiplicative phase The sporozoites circulate for less than 30 minutes and disappear into the liver cells where they multiply for the next seven to ten days into 'schizonts', each of which contains several thousand minute parasites These break out of the liver cells and enter the red blood cells (RBC), where they multiply, change into various forms and then break out of the RBCs, in the form of infective merozoites (Each sporozoite can give rise to 20,000 individual merozoites) The merozoites readily enter fresh RBCs, to repeat this cycle of events It is estimated that almost five per cent of the total RBCs are destroyed daily during severe malaria infection The repeated rupture and invasion of erythrocytes by the parasites at regular intervals constitute the clinical disease in the form of febrile attacks, chills and the accompanying symptoms like anemia, enlargement of the spleen and other complications

After a period of purely asexual multiplication in the RBCs, some of the parasites develop into sexual forms called "gametocytes' which are infectious to mosquitos These are picked up by the female mosquito when it sucks blood from infected persons In the mosquito, the gametocytes shed their RBC envelopes and undergo maturation into male (microgamete) and female (macrogamete) gametes over a period of 10 days The male gamete gives out a series of six to eight flagellae which break free and on encountering a female macrogamete, penetrate into it The fertilised zygotes differentiate well in the mosquito gut, multiply into various forms in the stomach of the mosquito, these finally become infective sporozoites that enter and accumulate in the salivary gland of the mosquito to complete the sexual cycle of development They are then ready for injection The development of the parasite in the mosquito takes 10 to 21 days depending on the environmental conditions such as temperature and relative humidity

Treatment

In the 17th century, Spanish monks discovered that cinchona bark was specific against malaria Quinine which is derived from the cinchona bark was the best example of specific chemotherapy though it has been superseded by drugs like atabrine chloroquine, primaquine, paludrine, pyrimethane and others However, it has no prophylactic action and no effect on the gametocytes Chloroquine and amidoquine are the cheapest and most effective However, the parasites are becoming resistant to the drugs and these drugs offer no protection against the relapse due to dormancy of certain strains of the parasite in the liver—which is frequently seen in malaria

Control

Data from various countries including India suggest that the cost of malaria control is from one-seventh to 1/15th of the economic toll levied by the disease Measures against the carrier mosquito have been more effective and more feasible than the other modes of eliminating the parasite, like the treatment of infected persons, the

protection of susceptible persons with prophylactic drugs or the reduction of the man-vector contact by the use of mosquito nets, screens or repellents. The concept of malaria control hinges on breaking the life-cycle of the parasite at one or more points. Complete interruption of the malaria cycle for three or four years wipes out the malaria infection, the few sporadic cases which remain being eliminated by surveillance and treatment.

Draining and filling of the mosquito breeding sites give permanent results but has severe limitations. Hence, the mainstay of malaria control programmes has been chemical control of mosquitos by repeated applications of insecticides with residual effects like DDT, BHC and malathion.

The World Health Organisation launched a global programme after the Second World War to wipe out malaria. By applying DDT and other contact insecticides it has been possible to root out malaria from Greece, Italy and a number of endemic countries. In India, too, there was a remarkable drop in malaria mortality and morbidity since the National Malaria Control Programme (NMCP) was launched in 1953. From the 75 million annual cases or so, there was a drop to 100,000 cases in 1965, with no deaths. Thereafter the incidence has been rising, particularly *P. vivax* cases which stood at 6.5 million in 1978, with many deaths. In general, the incidence of malaria in the south-east Asian region has doubled and it continues to be a menace in tropical Africa with nearly 96 million cases and an annual death toll of one million—mostly children.

The resurgence of malaria in India has been attributed to practical difficulties of implementing an appropriate eradication programme. The insect and the parasite have made things worse by acquiring resistance to the pesticides and drugs used to eliminate them. This resistance has been reported in 62 out of 107 malaria-affected countries. More than 20 species of anopheline vectors have now been found resistant to the organochlorine insecticides, BHC and dieldrin, as well as DDT. It was thought that mosquito resistance to DDT would subside when anti-malarial spraying was suspended, but this has not helped eradicate the disease; resistance can be built up by the sub-lethal doses (for the mosquito) used for protecting agricultural crops. Also, a change in the behaviour of the mosquitoes has been noticed in the eastern part of the country. Instead of feeding on the victims and resting on the walls of buildings, they bite humans outdoors and rest outdoors, thus avoiding contact with insecticide sprayed walls. The increase in the cost of the insecticides as a result of the oil price hike and the heavy dependence on imports to meet our requirements also contributed to this problem.

With new strategies adopted by the Government of India such as allocation of a major part of the health budget to the antimalarial operations and the treatment of every fever case with drugs readily made available, there has been a reported decline in the incidence of malaria recently. The problem, however, remains critical. Under these circumstances, alternative methods of control such as vaccination are of great interest and importance. Even the diagnosis of the disease poses problems.

Diagnosis

There is at present no simple, sensitive and rapid method for the early diagnosis of the infection and for an in-depth study on the epidemiology of the disease. The unequivocal method is still based on the identification of the parasite in blood smears taken from the patients. New methods are being developed for identifying the infecting species and for differentiating between past and present infections. Evaluation of the immunity status of the host against the infection is in progress in several countries. Several serologic indices are in vogue for an accurate appreciation of the prevalence of malaria. These tests help in establishing the incidence of malaria in the population including species prevalence and delineating malarious areas; they are also useful for identification and screening of blood donors who may be infected by malaria.

The methods currently adopted to control malaria are based on mosquito (vector) control by insecticides and chemotherapy. The resurgence of malaria in the face of these measures warrants a search for new tools for controlling malaria. Hence, the World Health Organisation selected malaria as one of the six tropical diseases in their Special Programme and is promoting intensive research in several areas to find such tools. This involves a search for more effective control of mosquitos by chemical (newer insecticides), biological (larvivorous fish, fungi or bacteria) and genetic methods (release of sterile males and introduction of strains with cytoplasmic incompatibility). Emphasis is also laid on finding out new chemotherapeutic drugs and even a vaccine against this disease. Research in these areas has become feasible largely because of the availability of a variety of host animals; in monkeys, *P. knowlesi, P. cynomolg* in birds, *P. gallinaceum, P. lophuras*, and in rodents *P. berghei, P. chabaudi*. These infections are, in general, species specific. The introduction of owl monkey *(Aotus trivirgatus)*, an exotic South American species as an animal model for the

Immunological tests

AMONG the more widely used tests in the field areas are the indirect hemagglutination (IHA) and indirect fluorescent antibody (IFA) techniques. The new enzyme-linked, immunoabsorbent assay (ELISA) is also being evaluated in several laboratories.

The antigen for the IHA test is a soluble extract of erythrocytes that are heavily infected with malaria parasites in the schizont stage of development. The blood is allowed to clot and the serum from the malaria patient containing the malaria parasites is mixed with antigen-coated particles. The agglutination reaction shows that the serum contains malaria antibodies which means that the person is infected. This test is sensitive and large numbers of sera can be examined easily; hence, it is eminently suited for field work. The IHA antibodies persist long after recovery from the disease.

The antigen for the IFA test consists of thin smears made of the infected individual's blood on glass slides. This is a highly sensitive test for diagnosis of malaria and readily reveals the exposure of an individual or community to malaria and may reflect malarial endemicity; it can also detect transmission. The IFA test becomes positive earlier than the IHA test in a malaria infection. The serum of an infected person when mixed with the blood film interacts with the antigen. The slides are rinsed of excess of antibody. The fluorescence labelled anti-antibody is then added to the film. The anti-antibody will react to the antibody, if any is present, and give a fluorescence when viewed under a microscope.

The ELISA test compares well with IFA for sensitivity and has great promise in seroepidemiology of malaria. The test, however, requires the use of purified antigens. The ELISA test is similar to the IFA test except that a marker enzyme, instead of fluorescence labelled antibody, is attached to the anti-antibody. Further detection is by a biochemical method which measures the enzyme activity.

Q.S.

most pathogenic malaria parasite of humans, *P. falciparum*, facilitated considerable research on this parasite.

In a country with poor sanitary conditions, which provide favourable breeding conditions for the mosquito, it seems a formidable task to achieve total mosquito control. There are also indications that both the mosquito and the malaria parasite could protect themselves from the onslaught of drugs by acquiring resistance. Under these conditions it would be ideal if methods are available to raise the resistance of the population by immunisation against the infection with an effective antigen(s) derived from the parasite. So far, it has been difficult to develop any effective vaccine against parasite diseases, barring in some instances by, the use of parasites whose virulence is reduced.

The main problems in developing such vaccines (as compared to antibacterial or antiviral vaccines) are that the parasite usually has several stages of development within the host. Hence, the antibodies effective against one stage are not usually effective against the other. Also, there is the problem of getting a sufficient amount of parasites at the desired stage of development. Further, the parasite releases factors that suppress the immune responses of the host.

Resistance to malaria infection

The resistance to malaria infection can be due to many different factors. A high protein (casein) diet or a diet deficient in para-aminobenzoic acid, a vitamin of the B complex group, can induce resistance in the animal. Recently, the precise mechanisms by which the parasites enter the red blood cells (RBCs) are being understood. The RBC seems to have a specific receptor which is recognised by the parasite. These receptors serve as sites of attachment for the parasites before they invaginate the cell and infect it. Miller and his colleagues at the National Institutes of Health, Bethesda, Maryland, USA, identified a human blood group called "Duffy" in man which is conducive eto infection with *P. vivax* and *P. knowlesi*. This explains the resistance of West African blacks and their descendants in the USA to *P. vivax* infection; they have a high frequency of the Duffy negative genotype. It is also known that in certain populations such as those deficient in glucose-6-phosphate dehydrogenase (SCIENCE TODAY, October 1976, p. 63), an enzyme vital for metabolising glucose in the RBCs of those suffering from sickle cell anemia, a hereditary disease, the parasite is unable to meet its nutritional requirements and thus cannot survive.

Why malaria staged a come-back?

THERE are several constraints in malaria control. These are as follows:

1. Increased costs of materials and equipment and global inflation;
2. Inadequacy of administrative and general services to support anti-malaria activities;
3. Shortage of trained manpower and difficulties in attracting and retaining experienced personnel;
4. Rudimentary health infrastructure in developing countries and limited involvement of rural health services in anti-malaria activities;
5. Factors of human ecology and ethology that interfere with the applications of anti-malarial measures (eg nomadism, replastering sprayed walls, refusal to accept the spraying of houses) or increased man-vector contact (makeshift housing, sleeping out of doors);
6. Difficulty of access to malarious areas for natural or security reasons;
7. Uncontrolled development of irrigation, deforestation and human settlement in malarious areas, and increased breeding of anopheles vectors;
8. Inadequate knowledge of the cost effectiveness of the various control measures under different local conditions;
9. Resistance of many vectors to insecticides that could be safely used in human dwellings;
10. Vector behaviour leading to avoidance of contact with the indoor insecticide deposit on walls;
11. Development of resistance in malaria parasites, particularly *P. falciparum*, to certain anti-malarial drugs;
12. Inadequate research support.

Protection by immunological methods

A malaria patient can get the infection repeatedly. Acquired immunity to the disease, although slow to develop, is associated with persistent low-grade parasitemia (presence of parasites in the blood) in many species including man. Nevertheless, several studies indicate that animals recovered from malaria have effective circulating antibodies (immunoglobulins) which protect them from further infection. Not all antibodies formed during parasitic infection would do this. Actually, a seven-fold increase in the immunoglobulin content is seen, much of which is not related to the parasite. Only a third of these proteins comprise antibodies directed to the malaria parasite, of which less than five per cent have protective properties. Available evidence suggest that this antibody belongs to the G class of the immunoglobulin (IgG) formed as a result of an effective co-operation between the cell-mediated (T-cell) and humoral arms (B-cell) of the immune responses against the invading parasite (SCIENCE TODAY, July 1980). Extensive researches are being carried out in several laboratories to find out the developmental stages(s) of the parasite that induces such a protective antibody in the hope that ultimately an antigen can be isolated from it for use as a vaccine. However, there are several problems here.

The several stages, such as sporozoites, merozoites and gametocytes, in the life cycle of the parasite add to the difficulty of immunising against malaria.

Nevertheless, much progress has recently been made in many laboratories in identifying certain stages of the parasite that could be used to induce effective immunity against malaria infection. The principal stages currently being investigated for use as immunogens are: (1) sporozoites, (2) asexual forms in the blood, (3) sexual forms and (4) non-living parasite antigens.

Sporozoites. Ruth Nussenzweig and her co-workers at New York University in 1970 effectively immunised rats and monkeys by using sporozoites of the appropriate species (obtained by dissection of salivary glands of infected mosquito or inoculated through the bite of infected, irradiated mosquitos) attenuated by radiation with X-rays or gamma rays. The radiation dosage was so selected as to abolish infectivity of the parasite but to retain its immunogenicity. This study was extended to human volunteers independently by D. F. Clyde and K. H. Rieckman (1974-1975). This involved exposure to several hundred infected mosquitoes irradiated at a dose of 12 to 15 KR (kilo rads). Three out of five subjects who were exposed thus were found to be immune to subsequent sporozoite infection against *P. vivax* and *P. falciparum*; the immunity lasts only for three and six months, respectively. The method, however, suffers from the drawback of requiring a large number of sporozoites, and the short duration of the induced immunity period.

Asexual stages. Similar attenuation of the parasite can also be induced by irradiation of RBC carrying the parasite; the radiation-treated parasites can then be used to induce immunity to the infection but only for the asexual stage.

S. Cohen and his colleagues at Guy's Hospital, London, found that the merozoites released from infected

[illegible] ... used to accept pride of place in the prevalent anti-malaria measures. Control of malaria. But after the discovery of the parasite's life cycle, the emphasis shifted to anti-larval operations. After the development of DDT, house spraying with this residual insecticide became the main anti-malarial measure. The use of anti-malaria drugs was reserved for the late stages of malaria eradication programmes. Later on, it was realised that house spraying has limitations under certain circumstances. Also, there is evidence that the widespread use of pesticides in agriculture has raised the resistance of the malaria carriers. The cost of insecticides, too, has risen lately.

Hence, where the aim is to reduce the mortality and morbidity, chloroquine and amidoaquine are the drugs of choice when the parasites are sensitive to drugs belonging to this group. Where *Plasmodium vivax* is predominant and where extensive use of pyrimethane has not led to the appearance of resistance, the use [illegible] ... against falciparum malaria. Constant monitoring of the parasites' sensitivity to drugs used is essential. The role of drugs is greater during malaria epidemics and when development projects give rise to a large influx of malaria cases. Chloroquinised salt may be used in certain areas where the salt intake is regular.

The emergence of *P. falciparum* resistance to chloroquine and the conversion of eradication programmes into malaria control programmes have made necessary some diversity in the selection of antimalarial drugs for different types of treatment. The WHO is promoting a global programme on monitoring the response of *P. falciparum* to antimalarial drugs.

Among the more promising new drugs are mefloquine which is highly effective in suppressing falciparum and vivax infections, it is also effective against chloroquine-resistant *P falciparum*. In the USSR, 4-aminobenzo (g) - quinoline has given promising results.

P K



RBGs are capable of inducing protection in monkeys. They devised effective methods to isolate this stage of the parasites. Two problems have been encountered in using this method, one of which is common to the sporozoite method, that is, the merozoites are needed in large numbers. Perhaps this problem can be tackled with the discovery of a new technique by W Trager and J B Jensen from Rockefeller University where merozoites of *P falciparum* are cultivated *in vitro*. This method has recently been adapted at the National Institute of Communicable Diseases at Delhi with some success on other strains, too. However, much work, is still required to increase the yield of the merozoites. Also, Cohen found that Freund's complete adjuvant, a chemical used to boost immune response of antigens, is essential for inducing protective immunity against merozoites. However, this adjuvant is not acceptable to humans for it triggers off arthritis and autoimmune diseases in predisposed people. W A Siddiqui and his colleagues at Hawaii University recently seem to have circumvented this problem by using muramyl dipeptide (MDP), a chemical derived from mycobacteria and recently synthesised, with adjuvant properties. Using MDP, these workers showed effective protection in *Aotus* monkeys against *P falciparum* infections.

Sexual stages. Successful attempts in immunising against the sexual stages of *P. gallinaceum* using radiation-attenuated gametes have been reported from the National Institutes of Health, USA. But the above methods suffer from severe limitations on the availability of adequate parasite material at that particular stage.

Perhaps, the ideal antigen for mass application should be a non-viable and a soluble component of the parasite which can immunise effectively in low amounts. Attempts are being made in this direction as well.

Non-living parasite antigens

A Zuckermann in Israel and G L Simpson in the USA and their colleagues have isolated various proteins from parasites released from red blood cells by applying latest biochemical techniques, and some of these were shown to be protective. From Rockefeller University, New York, USA, A Kilejian has reported that very effective immunity in ducklings against *P lophurae* occurred when a histidine-rich protein isolated from the parasite membrane was used. The existence of a similar protein was also observed in *P falciparum*.

Intensive efforts are also being made to identify and isolate malaria-protective antigens using genetic engineering techniques such as recombinant DNA, where the DNA of the parasite genome is fused with a genome of another species such as a bacterium. Efforts are also being made to isolate the messenger RNA from a parasite that makes the protective antigen when mixed with a protein translation machinery such as the rabbit reticulocyte ribosomal system.

The leads that certain parasite stages such as sporozoites and merozoites can induce effective immunity against malaria are being vigorously pursued. Functional antibodies are isolated by application of a powerful tool recently developed, largely by C Milstein and his associates at Cambridge, England. This is based on the demonstration that by fusion of myeloma cells with spleen cells from immunised animals, hybrid cell lines could be produced which secrete specific antibodies against the immunising antigen. Once this is achieved, it would not be a formidable task to isolate the corresponding antigens that elicit these antibodies from the parasites. This hybridoma technology has indeed been independently applied by two groups of investigators very recently to produce protective antibodies active against sporozoites and merozoites, respectively, of rodent malaria parasite.

With the resurgence of malaria in several parts of the world, research on methods to contain the infection has been intensified with financial support from national and international agencies. Consequently, there has been much progress in our understanding of the factors that induce protection against the infection. There is obviously a great need for sustained efforts in this area which could eventually lead to the most promising method of immunisation, keeping in view various factors such as availability of the material, effectiveness against different stages, strains, variants and other protean manifestations of the parasite.



Dr Subrahmanyam is Director-designate of a multinational medical Research Centre in Bombay. Till recently Professor and Head of the Biochemistry Department, Post-Graduate Institute of Medical Education and Research, Chandigarh, he has 28 years of research experience. His main research interests are in the fields of immunology of communicable diseases such as malaria, filariasis and tuberculosis, nutrition and infection, clinical and environmental biochemistry and he has published over 120 papers in these areas. He is member of the WHO Expert Committee on Parasitic diseases.

Environmental improvement for malaria

T. Ramachandra Rao

THE recent resurgence of malaria in the country, the almost near-stagnation in the control of filariasis, the persistence and spread of some arbo-virus diseases, the recent epidemics of kala-azar and the lack of improvement in the house-fly situation in rural areas raise many fundamental questions about our general attitude to the control of vector-borne diseases. When residual insecticides, DDT being the most important of them, was first introduced in this country in the mid-1940's, great hope was raised that at last we had a perfect weapon to deal with vector-borne diseases. Particularly after the early spectacular success against malaria, the attitude was: "Let the insects breed wherever they like so long as they come into our houses and cattlesheds for feeding or resting so that they will be killed by contact with the insecticide deposits."

However, disillusionment came soon (SCIENCE TODAY, May 1977, p. 40). Not that insecticides do not have a place in tropical hygiene; they still have some effect here and there. But it is the over-reliance on the widespread use of residual insecticides for the control of vectors that needs careful thought. Because of the development of resistance, insecticides, sooner or later, are likely to become ineffective. To use insecticides in places where they are ineffective would be pointless besides being wasteful; and where they are still effective, they require recurrent applications and constant vigilance.

So what are the alternatives? A scientific method would be to consider and test the pros and cons of several approaches and decide upon a single method or a combination of methods based on both technical and economic considerations. The present programme of extensive use of chemotherapic drugs, though logical and inevitable in the existing circumstances, is only temporary. It does not prevent the actual transmission, except marginally. Besides, how long will the drugs themselves continue to be effective? Our scientists should now begin to think of other permanent measures to meet the problem of vectors. While an integrated programme of residual insecticides, pyrethrum space spraying, recurrent anti-larval measures and chemotherapy would have to be initiated and continued to be used in various combinations for some time to come, we should ask a fundamental question: why should the vectors be allowed to breed, thrive and multiply and then take steps to destroy them? Is it not possible to do away with them at their sources?

All vector-borne diseases are caused by the environment, that is, the areas surrounding towns and villages provide favourable conditions for the growth, multiplication and spread of the vectors. Though all vector-borne diseases are not amenable to environmental control at present because of our lack of knowledge of the habits and habitats of many of the vectors and the complexities in the epidemiology of the diseases they transmit, diseases like malaria, filariasis, guinea-worm, dengue, etc can be brought under effective control by environmental methods. We shall here discuss some major aspects of environmental improvement for malaria control. But a distinction should be made between environmental control and environmental improvement. While environmental control includes all types of measures, permanent and recurrent, necessary to destroy the vectors and their breeding in the surroundings of villages and towns, environmental improvement is more specific and relates only to the measures which help in preventing the occurrence of breeding and resting places of the vector. It is the elimination of the vector by permanently removing the sources. Environmental improvement is a long-term method. Till it is fully achieved, recurrent measures would have to continue, but once environmental improvement is fairly well achieved, the need for recurrent measures is greatly reduced.

There are about half a dozen major malaria vectors and an equal number of minor or local vectors, each having its own features of bionomics and ecology. It would be wrong to expect that all the vectors are amenable to elimination by simple methods of environmental improvement. The vector most suitable for this purpose is *A. culicifacies*, which is the most common species. *A. stephensi* in urban areas poses no technical problems at all. *A. fluviatilis* and *A. minimus* come next in importance; though they occur in certain hilly and forested areas, because of their specialised and limited breeding places such as flowing streams and channels, they can be reasonably controlled by environmental improvement. And so is *A. philippinensis*, but its occurrence in deltaic areas surcharged with ground water would pose some problems.

A. balabacensis is a species which does not seem to be amenable to control by environmental improvement by the present known methods because it breeds extensively in numerous rain-water puddles in vast forest areas with widely scattered human populations. *Balabacensis*-transmitted malaria would have to be tackled by a combination of several methods such as chemotherapy, insecticide sprays, anti-larval measures and sociological changes and has to be treated as a problem by itself. *A. sundaicus* is also perhaps difficult to control by environmental methods, but it has undergone a great recession during recent years. Though today it is not a vector of much significance, its past history shows that it could suddenly spread out into new areas and may again come back into coastal areas of Orissa and Andhra Pradesh Minor vectors like *A. annularis*, *pallidus jeyporiensis* var. *candidiensis*, *maculatus* var. *willmoroi tessellatus* and *varuna* are by and large amenable to control by environmental improvement within well-defined areas. While a programme of environmental improvement could, therefore, be expected to reduce malaria incidence considerably in a major part of the country, it cannot be applied with equal effect in all parts. Better knowledge of the bionomics and ecology of the vectors and development of good water management techniques may help in extending the areas suitable for such control.

For purposes of environmental improvement, the entire country can be classified broadly under five categories with some overlapping.

Urban areas: Urban areas account for 15 to 20 per cent of the entire population. The vectors are *A. stephensi* or *A. culicifacies* or both, the habits and habitats of which are well known. There does not appear to be any technical or economic problem in achieving a good degree of control. Urban areas are most suited for environmental improvement. What was lacking was the will to undertake the programme and a certain amount of spoon-feeding of the local administrations by the central and state governments which had taken away the initiative from the local bodies. Malaria in urban areas is thus an

administrative and management problem.

Rural areas with rain-fed water sources. In a large part of the country, villages depend entirely on rain for water for domestic and agricultural purposes. The vector in most cases is *A. culicifacies* the breeding habits of which are very well known. Except for a few wells and perhaps a tank or two which the villages cannot do away with, many other types of breeding places can be eliminated by filling, levelling or drainage. Preference could be given to the cultivation of dry crops which do not require standing water. The wells and tanks themselves can be kept free of anophelines by temporary methods, including the use of non-residual larvicides like paris green and malaria kept under check by a little spraying of pyrethrum extracts at the appropriate time. In most cases, it would not be necessary to go beyond a radius of 0.5 km for the elimination of breeding places but considering that the vector can infiltrate from longer distances, the method would work best when a fair number of contiguous villages are taken up simultaneously for such work. Even if there is a little infiltration, malaria incidence would be negligible if the densities are kept low.

Villages situated along perennial streams and rivers. While towns and villages situated along large rivers which flow from bank to bank during most of the year may not require any special attention, villages along small streams and rivers with a tendency to develop river-bed pools suffer from intense malaria. The vector is almost invariably *A. culicifacies*. A good programme of minor engineering within about 0.8 km of the towns to prevent formation of stream-bed pools could be easily organised. In rocky stream-beds, a programme for connecting individual pools by blasting and creation of channels to take the water away to a main stream and permanently filling up others would be feasible. In sandy river beds, however, pools often form at different places and it may perhaps be necessary to fill such pools every year by sand or to make channels which drain away the water into the main stream. Villagers often dig pits in the sandy bed to get water, but if those shallow pits can be filled up and new ones dug every week or fortnight, they can be harmless. At any rate, such pits are not likely to be many in the vicinity of any single village. In such a situation, a minimal anti-larval programme using larvicides may also be necessary; it could be minimised and avoided if the stream-bed is properly improved.

Rural areas with irrigation. Conditions in these areas are more complex than in the purely rain-fed areas because of the extensive use of irrigation water. *A. culicifacies* is the main vector, but in certain areas, such as the Deccan, *A. fluviatilis* and *A. stephensi* can also play their parts in transmission. Breeding may occur in the channels, in rice fields during the early part of rice-cultivation and in vast areas of waste irrigation water. Even here, some methods of environmental improvement have proved useful. These are: (i) prevention of *wet* cultivation within 0.5 km of any village; (ii) improvement of the channels and seepage drains within the zone by stone-pitching or cement-lining to prevent both seepage and the breeding of the vector in the channels; and (iii) adoption of a system of intermittent irrigation in the outlying areas, a practice which needs some critical attention by our agronomists. They should help in developing not only proper irrigation practices, but also evolve strains of rice which can grow in dry or semi-dry fields (Is a standing water of 6 to 8 cm absolutely essential for rice growth?). This not only reduces mosquito breeding, but also conserves water. The elimination of waste irrigation water by filling up all unnecessary pits and depressions can lead to a great reduction in vector densities. And what little breeding still occurs after the elimination of breeding in the pits, ditches, waste irrigation water, unnecessary wells, etc may be controlled by some amount of recurrent larvicides.

In vast areas, lift irrigation is being practised, using electric power. Many areas which were formerly healthy have become malarious, mainly because of unrestricted use of water for cultivation, creation of shallow pits for storage of water, etc. Stringent methods to avoid accumulations of water and adoption of a practice of periodical drying can bring about a great reduction in malaria incidence.

Villages situated in forest or hilly areas with A. fluviatilis, A. minimus *and* A. Balabacensis. Because of the specialised habits of *A. fluviatilis* and *A. minimus* which breed in streams and channels with a perceptible flow, proper alignment and clean weeding can keep the vector densities low. But at present one cannot foresee how malaria can be controlled by environmental improvement where *A. balabacensis* is a vector. Such areas should receive special attention both in the use of insecticides when they are effective and chemotherapy to give relief to the people.

Environmental improvement can completely eliminate local transmission in a large number of villages in the rain-fed areas (nearly a quarter of the total number of villages), giving almost permanent benefits. It can *substantially reduce* malaria incidence in about another quarter of villages. These are also mostly in rain-fed areas with some irrigation under tanks or with perennial streams nearby. Some additional recurrent measures would be necessary, particularly pyrethrum sprays.

In areas under intense irrigation and the concommitant abundance of water, a rational use of water and elimination of unnecessary water collections can reduce malaria incidence in the course of years. These account for about another quarter of villages. The existing methods of residual insecticide sprays *where effective* and chemotherapy would have to be continued. Pyrethrum sprays can also be adopted in many localities.

There would still be about a quarter of the number of villages, where environmental methods *cannot be applied* as we now understand them. These are the problem areas in the hilly and forested regions where intense studies have yet to be conducted and newer methods developed. Urban areas are kept completely out of this classification because there is no alternative to environmental improvement which is entirely feasible and economical.

Finance may appear a formidable obstacle, but if funds sanctioned for the National Malaria Eradication Programme are re-allocated it will not be a constraint. Even if a third of the Rs. 75 crores being spent on malaria control each year (certainly not towards malaria eradication) could be diverted to environmental improvement, marked progress can occur in a few years. At a rate of Rs. 10,000 per an average village of 1,000 persons spread over a period of three years, 75,000 villages in the country can get the benefit of a permanent reduction in malaria incidence. In a national programme spread over 10 years, over 2,25,000 villages can be made comparatively malaria-free with the available funds and still the remaining Rs. 50 crores per year would be available for chemotherapy and carrying out other recurrent methods.

One of the weaknesses of the current national programmes is the total indifference of the people. They have taken malaria control and malaria eradication to be the sole responsibility of the government. People in every village should be encouraged to develop some degree of self-help and self-reliance.

Dr. Rao is a former director of the National Institute of Virology, Pune

Clearasil
Now in a new International pack



Clearasil helps clear and control pimples to keep young faces pretty



Unique 3-way action
Only Clearasil acts in three ways



1. Opens pimples —special medication helps peel away affected pimple caps



2. Clears pimples —helps pimples to drain without harmful squeezing



3. Dries up pimples —absorbs excess oil to help clear away pimples

Pimples are a part of growing up.
All you need is a little patience... and Clearasil

Clearasil World's No.1 pimple cream

OBM/8071

Superconductivity at high temperatures ?

AT LOW enough temperatures, many metals undergo a phase transition into a superconducting state which is characterised by infinite conductivity. "Infinite conductivity" means simply that a supercurrent, once started, does not decay even when the voltage source is removed. Further, the flow of supercurrent is reversible and this implies that there are no losses due to ohmic heating of the wire. It is clear, therefore, that enormous amounts of energy can be saved by transmitting power over superconducting lines and there are, in fact, a number of other uses to which superconducting technology can be put. That such a technological revolution has not taken place yet is due solely to the fact that the maximum known superconducting transition temperature is only about 23°K for which elaborate cryogenic techniques involving liquid helium are necessary.

Another and a more fundamental characterisation of the superconducting state is that no flux can be trapped inside a superconductor kept in a small static magnetic field. It implies that for a superconductor the static susceptibility $\chi = -1$ in MKS units. This is known as the Meissner effect.

Recently F. Brown, C. G. Homan and R. K. MacCrone (*Physical Review Letters* 45, 478) have reported the observation of nearly 100 per cent flux exclusion in certain samples of pressure quenched cadmium sulphide (CdS) at 77°K in static susceptibility measurements. Pressure quenching is the sudden release of pressure at rates greater than 10^6 bars per sec and is analogous to temperature quenching by which many metastable states are obtained.

Since the observation of the near total flux exclusion is very sample dependent we summarise below the main results of the characterisation carried out by the authors. (1) most important, only those specimens which have been quenched from above 40 kilobars show the large diamagnetism relevant to our discussion, (2) after pressure quenching, the room temperature resistivity is more than 10^4 times smaller than in the starting material which now shows a black sheen, (3) results of a wide variety of tests indicate that the relevant samples have transformed from a wurtzite structure to a mixture of zinc blende and NaCl structures, (4) finally, the source of derivation of the starting material turns out to be very important, although there is no knowledge of which impurities are responsible directly or indirectly for the large diamagnetism.

Although the magnetic properties of the appropriate samples of CdS show a similarity to the usual Type II superconductors, they also show a metastability not observed in stable superconductors. In particular, the diamagnetism almost disappears after the sample is put through a slow warming (to room temperatures) and recooling cycle.

As the authors point out, measurement of the electrical conductivity as a function of the magnetic field would confirm the presence of superconductivity. Contactless techniques (necessary because of the complex morphology of the samples) to measure the conductivity are being developed, claim the authors. In sum, a lot more work in terms of sample characterisation and measurement of other physical properties remains to be done before pressure-quenched CdS is to be accorded the status of a high temperature superconductor.

PARTHA BHATTACHARYYA

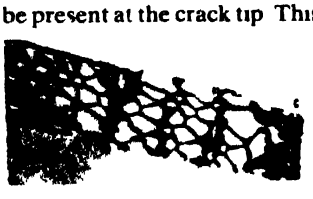
Dr Partha Bhattacharyya is with the Theory Group at the Tata Institute of Fundamental Research.

Ceramic cracks are atomically sharp

IT IS NOW well established that when a pre-cracked body of the more commonly used structural materials like metals or plastics is loaded, a plastic zone forms at the tip of the crack. The formation of the plastic zone invariably leads to blunting of the crack tip and contributes to the toughness of the material. To develop tougher materials and achieve a more reliable structural design, considerable investigations have been carried out in the last two decades on the mechanics of fracture in such materials.

A recent paper by B. R. Lawn, B. J. Hockey and S. M. Wiederhorn, *Journal of Materials Science* **15**, 1207, deals with cracks in ceramics and similar solids. As against metals and plastics, they found, these solids which are covalent and/or ionically bonded crack in a different way. They demonstrate through transmission electron microscopy that such solids crack without a crack tip plastic zone. The cracks are atomically sharp, implying that the radius of the crack tip is of the order of a few interatomic spacings.

Previous researchers contended that the plastic zone observed ahead of the indentation made in a ceramic must also be present at the crack tip. This contention has been invalidated by the present study; the authors argue convincingly that the stress field ahead of a crack is different from that ahead of an indentation. The authors examined, by transmission electron microscopy, one micrometre thick foils, where 'radial and median' cracks had been introduced by indentation and also by impact of hard particles on a thin specimen. The atomically sharp crack tip confirms the absence of a damage zone. This is an important observation.



Micrograph of the tip of a crack in sapphire

The existence of an atomically sharp crack raises an important question. In propagating a crack we create two new surfaces. Theoretically, it is then expected that the energy consumed in the propagation of a crack per unit area, Gc, should be equal to twice the surface tension of the material, 2γ. Large discrepancies in these values are explained in the case of metals and plastics as due to the formation of the plastic zone. Such discrepancies are much smaller in the case of ceramics. But then, how does one explain these minor discrepancies with atomically sharp cracks?

In this context, the crack tip models proposed by different workers incorporating the details of the atomic structure acquire importance. Such models at present are semi-empirical but the observed discrepancy can be explained in terms of the surplus energy required to overcome the lattice trapping of a crack as predicted by them. It must however be noted that these models have limitations. Apart from their inherent empiricism, such models cannot provide a detailed knowledge of the nonlinear nature of the atomic separation within the process zone of an atomically sharp crack. In the absence of the plastic zone, the exact nature of the atomic separation needs to be firmly established.

Doubts always arise about the relevance and applicability to bulk materials of the observations relating to dislocations and slips made on thin films. Besides, in the above experiments the crack grew under a decreasing stress intensity factor, K_I. The observed trend of results reported need to be verified in a case where K_I increases. Similarly, the observed sharpness of the cracks should also be verified under modes of loading other than the first mode. Finally, in the absence of active dislocations near the crack tip, it remains to be seen how a fatigue crack grows in such crystalline materials.

The main observations in the paper may have little direct application to the prevention and control of fracture in metals and plastics, but they give important and new directions in the control of fracture in ceramics and in the development of tougher ceramics.

S. BANERJEE

Prof. Banerjee is with the Department of Metallurgical Engineering, Indian Institute of Technology, Bombay.

Bioluminescence and its mechanism

BIOLUMINESCENCE is the emission of visible light by living organisms. Species displaying it are diverse, ranging from the single-called animals, fungi and bacteria to highly evolved animals and even plants; it is commonly found in marine organisms, many of which have developed remarkable uses for this light. Though this phenomenon has intrigued scientists for long, it was only during the last decade or two that the main features of its mechanisms were understood. Light emission from living organisms is due to the decay of a molecule brought to an excited state by a chemical reaction and hence it is a special type of chemiluminescence.

Formerly, a unique biochemical origin was attributed to bioluminescence, but now many chemically distinct bioluminescent systems are recognised. For example, the bacteria have flavin, a long-chain aldehyde; coelenterata to which jellyfish belong have coelenterazine, an imidazopyrazine; firefly benzothiazole; *Latia* (a mollusc), sesquiterpene; and earthworms have N-isovalcryl 3-aminopropanol: H_2O_2. Some systems have been isolated with the luciferin, a species-specific pigment found in many luminous organisms already in the form of a peroxide and bound to the protein (photoprotein). It has now been more or less established that the basic bioluminescent reaction is an enzyme-catalysed (luciferase) decomposition of peroxides. A few related phyla appear to use similar systems, but no one chemical system serves all the organisms. In fact, it was believed that the different bioluminescent systems in various phylogenetic groups have evolved independently and consequently are biochemically distinct. The similarities in the luciferins and luciferases in different organisms can be traced both by seeing if a light-emitting cross-reaction is possible between the chemicals extracted from each of them or by elucidating the chemical structure of the luciferins themselves.

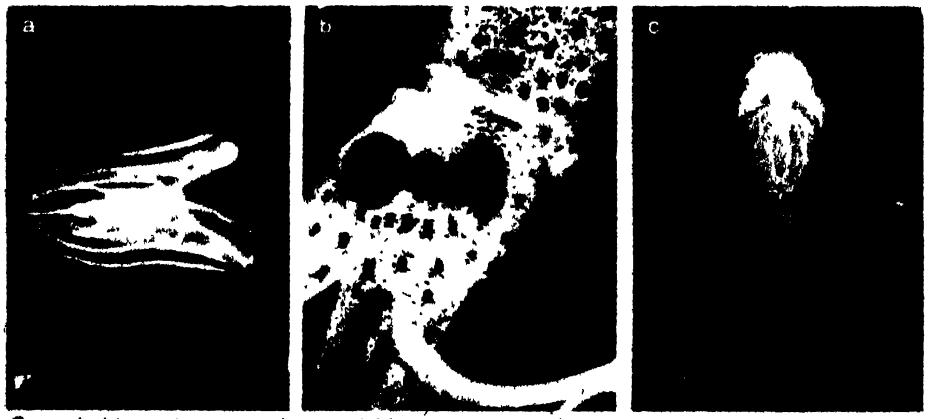
Recently, J.C. Dunlap, J.W. Hastings and O. Shimomura (*Proceedings of the National Academy of Sciences*, USA (77(3), 1394) studied cross-reactivity between the light-emitting systems of distantly related organisms like the dinoflagellates (an order of flagellate protozoa) and the euphausid shrimps which emit a brilliant blue light. They observed that dinoflagellate luciferin (LH2) cross-reacted and emitted light with euphausid photoprotein (PP), and euphausid fluorescent substance (F) gave luminescence with the dinoflagellate luciferase. This finding seems remarkable in view of the phylogenetic distance between the two groups and even more so considering that the biochemical mechanisms are apparently distinctly different in the two systems. In the dinoflagellates, there is a classical enzyme substrate reaction, whereas in the euphausids there is a special type of photoprotein system in which F catalyses the oxidative decomposition of photoprotein (PP) with light emission from F. Interestingly, though the possibility of these two low molecular weight molecules evolving independently exists, it is also possible that the euphausid shrimps utilise the nutritionally derived dinoflagellate LH2 and after chemical alterations adopt it as a fluorescent substance.

It has recently also been shown that the breakdown of certain cyclic peroxides is catalysed by certain dyes with low oxygen potential and that the resulting light emission involves the excited state of the participating dye. Maybe such a mechanism is involved in the breakdown of PP by F.

Bioluminescence has already been used as a tool in the detection of oxygen, traces of pollutants, calcium, adenosine-triphosphate, diphosphopyridine nucleotide and coenzyme A. The subject, no doubt, provides a fascinating and fertile field of research, especially for ecologists and evolutionary scientists.

M. S. REGE

Dr. Rege, a marine zoologist by training, is now engaged in research in Environmental Biology at the Institute of Science, Bombay



Some light-emitting organisms: (a) Mnemiopsis—kind of comb-jellies, which on stimulation emit bright flashes; (b) a deep-sea squid, with many photophores on the ventral surface and tips of the tentacles; (c) a deep sea fish with ventral photophores which are used in courtship

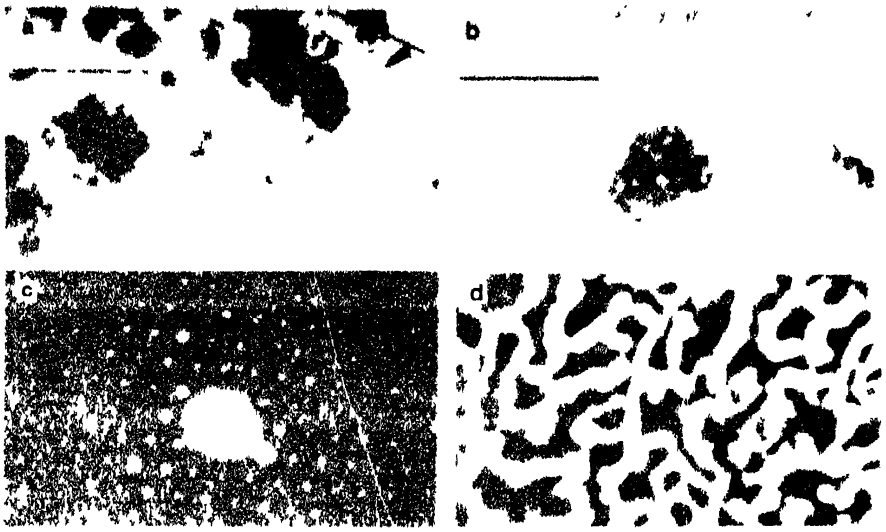
Pre-solar grains in meteorites

SINCE the last ten years, carbonaceous chondrites (CC) have been extensively investigated for records of events that took place in the early solar system. They show signs of least alterations and their chemical composition matches with the universal abundances. Some minute mineral phases in CC meteorites revealed variations in the isotopic composition of elements such as O, Mg (due to ^{26}Al decay) which lead to a radical change in our understanding of the origin of our solar system.

Recently Ed Anders and his co-workers at Chicago, in collaboration with Greenville Whittaker of Aerospace Corporation, California (*Science*, **209**, 1512) detected pre-solar carbon grains, containing carbynes in two CC meteorites, Allende and Murchison. After treating these meteorites with acids to remove silica, a carbon-rich residue was separated which on electron diffraction analysis showed different forms of carbon. These polymorphs of carbon are very different from graphite and diamond and they are termed as C_α, C_β, amorphous carbon, etc. These various unfamiliar forms of carbon are known as carbynes.

The carbynes occur in CC meteorites as carbon grains 0.04 to 0.75 microns in size and their maximum lattice spacings on C-axis pattern (d_{max}) match 5 known carbynes C-VI, VIII, X, XI and XII. The ion-etching pattern shows at least two of the four carbynes in Allende formed simultaneously and the interlocking, vermicular texture shows that they grew together *in situ*. Whittaker in 1978 studied several terrestrial graphites and showed that the carbynes form and persist under metastable conditions. Three of the four Allende carbynes transform to graphite or amorphous carbon on heating and hence might have formed at low temperatures. On the other hand, the Murchison carbynes are thermally stable and hence might have formed at higher temperatures. The anomalous nature of Ne and Xe components in these grains favours a pre-solar locale such as red giants or novae.

Detailed mass-spectrometric studies of Allende carbon-residue revealed that the carbynes are triply-bonded elemental carbon. When pyrolysed at 250°C to 330°C, it releases organic fragments such as — $(C\equiv C)_n$— with $n=1$ to 5 and —$C(C\equiv C)_n$—CN with $n=1$ to 3. The prominent feature is the even number polycarbon series from C_4^+ to C_{10}^+. Also, cyanoacetylenes are commonly found. Allende represents the first extraterrestrial occurrence of natural carbynes. Though carbynes are known to form only by condensation of carbon vapour above 2600°K or by explosive shock of > 600 kilobars, these carbynes in CC meteorites could have hardly formed as equilibrium condensates of carbon vapour. R. Hyatsu



The figure shows carbynes in Allende meteorite Scale bars, 1 micron (a) Typical irregular carbyne grains (b) One of the two faceted crystals of typical carbyne morphology (c) Electron diffraction pattern of a carbon VIII grain (d) A stereo view of the ion beam produced etch pattern

and team (*Science* **209**, 1515) showed that these carbynes in nature can form metastably by the reaction of $2CO \rightarrow CO + C$ at 300° - 400°C in the presence of chromite catalyst Such low temperature formation by surface catalysis may be the dominant source of carbynes in meteorites and earth and a major source of interstellar carbynes and cyanopolyacetylenes It is remarkable that so-well-studied and abundant an element such as carbon should still yield surprises of this nature

M N RAO

Prof Rao is with the Physical Research Laboratory Ahmedabad

Ultraviolet may reveal neutrinos

DO NEUTRINOS have mass? The answer to this question may be provided by ultraviolet astronomy according to two famous American physicists

Astrophysicists have been interested in finding the missing mass in the universe It has been suggested that the missing mass may be in the form of dim or defunct stars or black holes Ever since the experimental suggestions about the possible non-vanishing mass for the neutrinos came up (SCIENCE TODAY June 1980, p 25), astronomers seriously started considering the possibility that the neutrinos indeed, provide the missing mass These neutrinos could be present in large numbers pervading the halos of galaxies (SCIENCE TODAY November 1980, p 26)

Two arguments make the consideration of neutrinos as the agents for the missing mass plausible First, from the microwave background radiation measurements it is inferred that the photons outnumber the baryons by almost a factor of 10^8 But the photons being massless (and the bulk of them having low energies) are not able to provide the requisite density to close the universe However, if neutrinos possess even a few tens of electron volts/c^2 mass, they will be able to close the universe The second consideration is based on the binding of neutrinos to the galaxies For neutrinos to be bound to the galaxy they should be massive enough and their velocity should not exceed the escape velocity (from the galaxy) This means that the neutrino mass should be at least 24 eV/c^2

If the neutrinos filling the galactic halos possess mass, how can they be detected? This forms the basis for a paper published in *Physical Review Letters* (**45**, 942) by the American Nobel Laureate S L Glashow and A De Rujula The heavy neutrinos will decay by emitting a lighter neutrino and a photon The photon energy in the first approximation can be equated to half the mass of the heavy neutrino From the consideration that the mass is of the order of a few tens of electron volts it is easy to show that the photon will be emitted in the ultraviolet energy range For calculating the flux of these ultraviolet photons it is necessary to know the decay rate of the heavy neutrinos In other words, we need to know the lifetime of the neutrinos From theoretical consideration, the authors conclude that the lifetime may be about 10^{22} to 10^{28} years If this were indeed the true lifetime then the ultraviolet photon flux from our galaxy will be about 1 photon/cm^2 sec This is too small for the present instruments to detect But there are considerable uncertainties at the present time in the derivation of the lifetimes, etc With reduced uncertainties in such estimates in future there is perhaps a remote possibility that UV astronomy will decide whether we live in a neutrino-dominated universe

S. RAMADURAI

Dr Ramadurai is with the Astrophysics Group at the Tata Institute of Fundamental Research Bombay

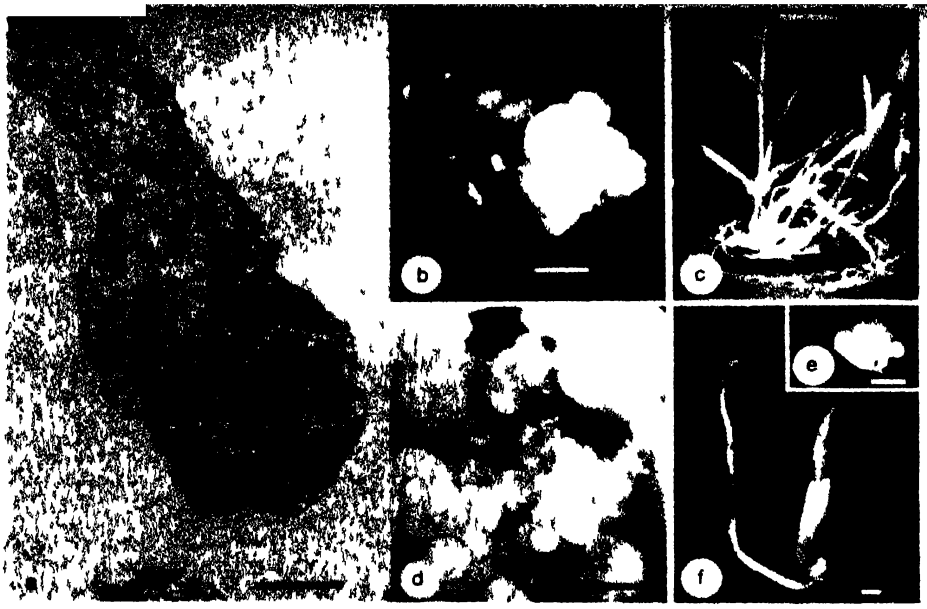
New light on cereal tissue culture

CONVENTIONAL methods of plant multiplication are through seeds and seedlings, stem cuttings, rooting of branches and other vegetative plant parts However, in economically important plants, difficulties are encountered in propagation and the multiplication ratio is small

In essence, plant cells are 'totipotent", which means, each cell, given the proper nutrient conditions, is capable of developing into a complete plant Recent researches in plant sciences have enabled the scientists to raise plants in test tubes by growing plant cells and tissues aseptically on a nutrient medium under controlled environmental conditions (SCIENCE TODAY June 1976, p 13) Plant tissue culture technique involves isolation of any living tissue like the stem, leaf, root, part of a flower or shoot apex from a plant under aseptic conditions and growing it upon a sterile medium containing the necessary plant nutrients Depending upon the nature of plant growth hormones included in the medium, the tissue or cells are stimulated to produce leafy shoot buds which can be further induced to root and develop eventually into complete plants

Alternatively, plant cells may undergo extensive division resulting in a proliferated mass of tissue the callus, which is capable of undifferentiated growth The calluses are amenable to experimental manipulation For example, by varying the concentrations of growth hormones, it is possible (a) to convert the cells into embryos which can develop into complete plants or (b) to induce the formation of shoots and roots which eventually develop into plants Cell cultures have therefore become a unique experimental tool and a great deal of interest has been generated towards using this system in plant improvement programmes

Although extensive work has been carried out in many plants, investigations on crop plants notably cereals, have been rather meagre Protoplast (plant cell without its cell wall) culture and hybridisation can be used as an effective aid to improve cereal crops However, a prerequisite for this approach lies not only in obtaining a high yield of protoplasts but also in regenerating them into complete plants The most convenient source of plant protoplasts is the leaf tissue However, sustained cell divisions have never been obtained from cereal leaf protoplasts, for reasons not understood A recent paper by W Wernicke and R Brettel (*Nature* **287**, 138) has thrown light on this aspect The authors excised leaves of different ages of a jowar species, *Sorghum bicolor* and cultured them on a nutrient medium Many combinations of plant hormones were tested Encouraging results were obtained only with the youngest leaves The leaf pieces pro-



(a) Cross-section of a leaf piece cultured on a nutrient medium for five days shows excessive cell-proliferation towards the lower side (b) callus growing from a leaf piece (c) plant regeneration from b wherein shoot growth is accelerated (d) embryogenic tissue (white globular structures) resembling zygotic embryos obtained from b (e) isolated somatic embryo (f) germinating somatic embryo

liferated and developed into a tissue which could regenerate into shoot and plantlet or formed globular structures which eventually developed into embryos

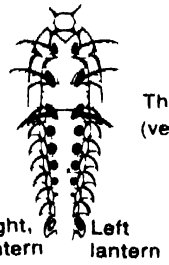
The findings are significant and bear two important implications on cereal tissue culture First, it shows the possibility of utilising *Sorghum* leaf tissues for establishing tissue cultures which have the potency to differentiate into shoot or embryos and finally into a complete plant Second, the knowledge accruing from this study may be useful in the successful isolation and division of protoplasts from leaves of desired *Sorghum* lines which is a prerequisite for studies on hybridisation of protoplasts

P S RAO

Dr P S Rao is head of the Plant Morphogenesis and Tissue Culture Section Bio-organic Division Bhabha Atomic Research Centre Bombay

Fireflies emit circularly polarised light

A RECENT communication by Prof Hans Wynberg and co-workers (*Nature* **286**, 641) reports intriguing observations on the light emission from firefly larvae of *Photuris lucicrescens* and *Photuris versicolor*, (both species belonging to an extensively investigated American firefly family of terrestrial bioluminescent organism) They examined the polarisation of the light emission from the whole animal and found that the left lantern emitted circularly polarised light of a sense opposite to that emitted by the right lantern



The firefly larva (ventral view)

The emission of light in these organisms is believed to arise from the enzyme (luciferase) mediated oxidation of luciferin to yield a high energy intermediate which decomposes to form the emitter molecules in the excited state The authors believe that the origin of circular polarisation of bioluminescence (CPBL) must lie in the microscopic phenomena rather than in the molecular chirality of the emitter system They hypothesise that the light from the bioluminescent emitter may be plane polarised by the inhomogenous formation of excited states due to the local molecular organisation in the light-emitting cells of the firefly This plane polarised light is elliptically polarised while passing through the oriented biopolymers in the lanterns which function as a birefringent medium According to the authors, the CPBL of opposite sense may be a consequence of the mirror image relationship of the membranous structure and orientation of the emitters within the lanterns The lanterns themselves are enantiomeric and the larvae, like many other living systems, are bisymmetrical The authors suspect that CPBL of opposite sense may be observed in other bioluminescent organisms with enantiomeric lanterns as well.

S S TALWAR

Living electrode for biophotolysis of water

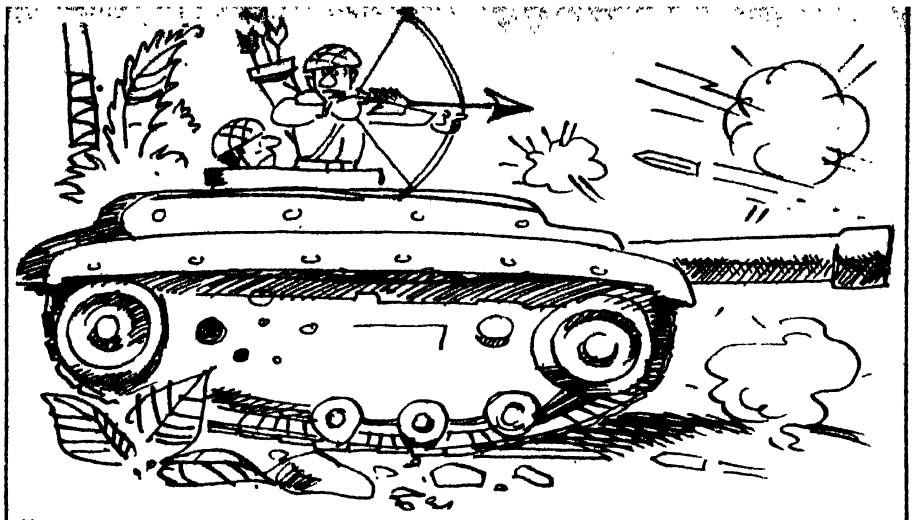
THE search for alternative sources of energy has led to intensive work on biophotolysis of water using solar energy for the production of hydrogen Biophotolysis involves the coupling of the natural photosynthetic systems of green plants and algae with hydrogenase (from algal or a bacterial source) to liberate hydrogen from water, the photosynthetic system acting as the harvester of the solar radiation That hydrogen is liberated on illuminating a system containing spinach chloroplast, ferrodoxin, hydrogenase and water was established by Prof M D Kamen of the University of California at San Diego in 1973

However many technical problems need to be solved before this plan becomes practical The photosynthetic systems *in vitro* lose their activity under constant and high intensity illumination, this underlines the need to extend their active lifetimes A group of five Japanese scientists led by Hideo Ochiai working at Shimane University, have made some promising observations with immobilised whole cell thermophilic blug-green algae *Mastigocladus luminosus* (*Proceedings of the National Academy of Sciences* USA 77 2442) The intact algae cells were found capable of transfering electrons to electron carriers such as 3-(3, 4 dichlorophenyl) 1, 1-dimethylurea (DCMU) In fact, algae was immobilised with polyvinyl alcohol (PVA) onto tin oxide(SnO_2) electrode Illumination of this electrode with visible light absorbed only by algae generated photocurrent without decay for 30 minutes The algal electrodes retained their activity for several days More significantly, calcium alignate-immobilised algae electrodes dipped in a culture medium were able to generate a steady photocurrent on continuous illumination for more than 20 days During this period algae remained alive and grew in the alginate matrix, indicating that algal electrode could function as a living photoconverter The living electrode' does hold promise as an electron-donating system for coupling with hydrogenase for hydrogen production But immobilising material with higher conduction would be required to achieve efficient photoconversion

Another problem that awaits solution is the of loss of hydrogenase activity caused by the evolved oxygen

S S TALWAR

Dr Talwar is with the Department of Chemistry, Indian Institute of Technology Bombay



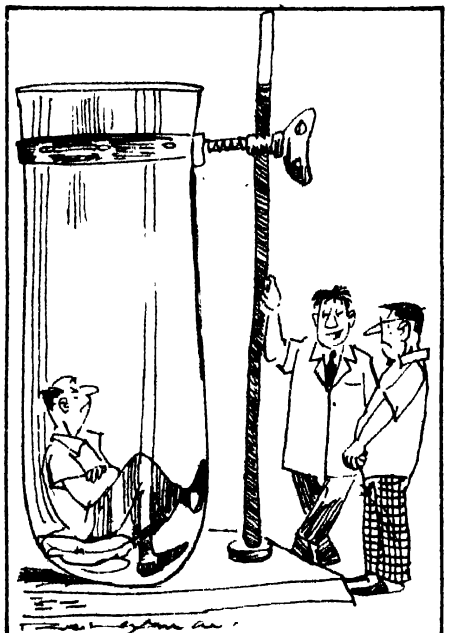
You must be self reliant where arms and ammunition are concerned. This sort of dependence on uncertain imports won't do.

This World of Science!

by R. K. Laxman



Is that the cigarette lighter you said you made yourself?



Remember the test-tube baby? We had to keep on increasing the size of the test-tube—he refuses to step out



Father, you are still making gold—the world needs uranium!



It is generally known that the Rev. Thomas Robert Malthus' "Essay on the Principle of Population as it affects the Future Improvement of Society," provided the spark, as it were, that Darwin needed for illuminating his theory of Natural Selection. What were Malthus' own views on evolution? In the essay he describes the process of evolution by means of an analogy: "a writer may tell me that he thinks man will ultimately become an ostrich. . . before he can expect to bring any reasonable person over to his opinion, he ought to show that the necks of mankind have been gradually elongating; that their legs have grown harder, and more prominent. . . and that the hair is beginning to change into stubs of feathers. . ."

*

LEWIS CARROLL, the 19th century mathematician and author of "Alice in Wonderland", offers the following practical advice on problem solving: "when I come upon anything—in logic or in any hard subject—that entirely puzzles me, I find it a capital plan to talk it over aloud, even when I am alone. One can explain things so clearly to one's self. . . one never gets irritated at one's own stupidity."

C.D'S.

*

ACCORDING to Newton's contemporary and friend, the astronomer and mathematician David Gregory—who claimed to have been the first to give public lectures on Newtonian theory—the great Newton thought that "a continual miracle is needed to prevent the Sun and the fixed stars from rushing together through gravity."

*

IN SPITE of having been well recognised as a ranking biologist, geneticist and a Marxist, too, J. B. S. Haldane at times avoided claiming to be a materialist because, "if materialism is true, it seems to me that we cannot know it is true. If my opinions are the result of the chemical processes going on in my brain, they are determined by the laws of chemistry, not those of logic."

*

WHO says a scientist cannot afford to speak a lie, in scientific matters at least? Even after the Renaissance, people held beliefs without bothering to find out their scientific validity. For instance, the noted chemist, Van Helmont (1577-1644) held: "One can produce mice at will by placing some dirty linen together with a piece of cheese in a container."

S. N. MUNSHI

Don't let a cold ruin your day.



A cold can be relieved

There is a way to relieve a runny nose or blocked nose, heavy head, sore throat and chest congestion—all those symptoms that can spoil the best of days

Fight it with a colds remedy

It's not enough to treat it like you would treat any other ailment Use a special colds medicine that works simultaneously on all affected areas

Coldarin is only for colds

Coldarin relieves all the symptoms that bring you down It has special ingredients that act together against all cold-affected areas Plus Vitamin C to build your resistance When you have a cold, it makes sense to treat it like a cold



COLDARIN

Specially formulated for colds

CASBC 64 242

camel ink

In six inspiring shades for smoother flow and beautiful clean writing



S 801

Nobel Prizes 1980

Physiology or medicine

THERE ARE two main hurdles in man's quest for immortality; attacks by disease due to microbes and the inevitable aging and degeneration of organs. That nature has endowed human beings with a built-in defence organisation—the immune system—to combat infection was recognised by von Behring, the recipient of the first Nobel award for physiology and medicine. Ironically, this very immune system has also been a stumbling block. The replacements introduced to take over the functions of the failing organ are rejected by the body. It was George Snell (76) of the Jackson Laboratory in Bar Harbor Maine, USA, who demonstrated that this ability to recognise a grafted organ as foreign, as distinct from "self", is a part of the individual inheritance. He shares this year's Nobel prize for physiology and medicine with Jean Dausset (64) of the University of Paris, France, and Baruj Benacerraf (60) of the Harvard Medical School, USA. George Snell believed that "there were genes that in some way determined whether or not an individual would accept or reject an organ or skin transplant. That is how the body recognises "self" from "non-self"

Snell started his work in the pre-war era of scientific research which was conspicuous by the lack of sophisticated electronic gadgetry. His old-school methods involved the patient breeding of mice that were genetically identical and then transplanting them with tissues or tumour grafts from other mice. This helped him identify the cell surface antigens and, in turn, the genes that controlled the graft rejection phenomenon. He called this group of genes the "histocompatibility complex" or the H2-locus. Mice of the same strain and the same H2 make-up would accept skin grafts. Those differing at the H2 locus would reject them.

Always a meticulous researcher and a perfectionist, Snell went on to breed purer congeneic strains of mice that were totally identical in their genetic constitution except for a small stretch like the H2-region. This has been the most creditable contribution of Snell, for these mice formed—and are still forming—the staple raw material of immunologists. The Jackson Laboratory at Bar Harbor, Maine, has been almost the sole supplier of this essential pre-requisite of most immunological investigations.

Creating these inbred strains of mice is a painstaking business. One starts with two totally different strains of mice, X and Y, and mates them to produce a hybrid which carries part of both the genetic stocks. These off spring are then repeatedly mated with one of the parental strains. This selective back-crossing moves each successive generation closer on the genetic scale, but painfully slowly. Once such congeneic animals are obtained they are then mated with each other to perpetuate their identity.

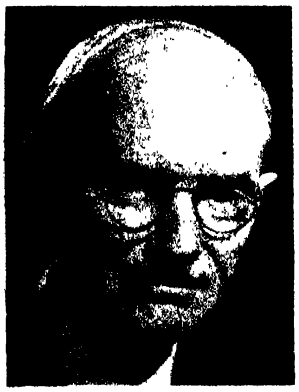
That organ matching in the human system can be done easily and quickly today is chiefly due to the work of Prof. Dausset. He showed that serological techniques used by Landsteiner in blood group determination were usually applicable for tissue typing. In the process, he also confirmed the existence of a histocompatibility complex in the human system. These "genes" which, according to Dausset, "showed a remarkable similarity to the mouse genes" are called HL-A (Human Leucocyte Antigen) genes. In both mice and humans, the histocompatibility genes code for specific proteins found on the surface of all cells in the body. Dausset then showed that what these blood cells did to each other in a culture dish was indeed the way the graft and the recipient reacted towards each other. This laid the foundation of the tissue-typing methods in vogue today.

Although concerned with a much more complex and weird system like the human, Dausset was able to go a step ahead and suggest that the HL-A genes are located together on the same chromosome. He has been proved right as these genes have now been mapped on the short arm of chromosome number six. Four genetic loci in the HL-A region have been identified so far. One of them exists in 13 different forms. A second one has 16 variants. Even if these two alone are considered, the chances for a perfect match works out to be one in 29,000.

Benacerraf, the third member of this group, who had his early education in Paris, was attracted towards the Frenchman's results. He was prompted to look more closely at the genetic basis of normal immune response against a variety of foreign antigens. In experiments with guinea pigs, he found genes that control the ability of an individual to respond to certain foreign substances. These genes, termed as 'Ir', that is, 'immune response', are in the same region of chromosome as the histocompatibility genes.

The real significance of Benacerraf's contribution lies not so much in the discovery of H-linked Ir genes but in the impact that it has on the health status of an individual. Benacerraf himself was acutely aware of this; these genes are responsible for the production of certain molecules which are on the surface of all cells and play a predominant role in the mechanism by which the lymphocytes recognise a "self" antigen from a "non-self". This recognition helps the body mount a vigorous response against "non-self" and at the same time avoid such reactions against its own constituents.

However, the corollary of Benacerraf's theory has been equally significant. For he had predicted that "the presence of H-linked Ir genes may have serious pathogenic consequences". This expectation has now been verified. Thus the capacity of mice to develop autoimmune thyroiditis and of rats to develop experi-



Snell



Benacerraf



Dausset

mental allergic encephalemyelitis is determined by the presence of H-linked Ir genes. In humans also, several crippling disorders like systemic lupus erythematosus, myasthenia gravis, rheumatoid arthritis or ankylosing spondylitis have been shown to possess a "highly significant" association with HL-A make-up.

Although the three Nobel laureates have been great friends, their backgrounds and styles make an interesting contrast

Snell is totally a product of the American Ivy League. Born and brought up at Hoverhill, Massachusetts, and trained at Harvard where he obtained a doctorate in genetics, he carried out his research at Jackson Laboratory, Bar Harbor, Maine. He has thus spent his entire life in New England. Perhaps, the ancestral Pilgrim Fathers who founded New England left Snell a legacy of their missionary zeal. It was quite fitting that he was the recipient in 1967 of a medal instituted by the Czechoslovak Academy of Sciences in honour of Gregor Mendel, the father of modern genetics. For Snell, there is no conflict between appropriate research and relevant technology, fundamental studies and applied extension.

If Snell is an old-style inhabitant of the New World, Jean Dausset is a typical French product, always bubbling with enthusiasm like French champagne. Born at Toulouse, he had his medical education at Paris. Research in hemotology attracted him and helped him establish the field of immunohemotology in his country. He is now professor at the College of France. This is the second award he shares with Snell, the first being the prestigious Wolfe Foundation Award.

Benacerraf is literally a man of the world. His is the most chequered background. Born at Caracas, Venezuela, he had some of his early education at Paris. For his university studies, he shifted to Columbia University, New York, and later to the Medical College of Virginia. He carried out his researches at several places, including Hospital Broussaid, Paris, National Institutes of Health, USA, and for the last decade at Harvard. He is considered an "entrepreneur of immunology". Benacerraf likes to play a patriarch surrounded by and leading a group of students, associates and colleagues, all on an identical quest.

G. P PHONDKE

Dr Phondke heads the Radiation Biology and Occupational Health Section, Medical Division, Bhabha Atomic Research Centre, Bombay, and is actively involved in immunology research.

Chemistry

A REMARKABLY large proportion of Nobel prizes for chemistry and physiology since the early fifties has gone to molecular biology, in particular, to the molecular biology of the gene. As if to underscore the fact that this series has not concluded, the 1980 prize for chemistry has been awarded to three molecular biologists whose work forms the backbone of recent DNA research. Frederick Sanger of the Medical Research Council's (MRC) Laboratory of Molecular Biology at Cambridge, England, and Walter Gilbert of Harvard University, USA, share one-half of the prize for developing highly original methods to find out the exact base sequence of DNA, while Paul Berg of Stanford University, USA, receives the other half for pioneering the techniques for constructing novel molecules by joining or splicing DNA from different sources. The contributions of Sanger, Gilbert and Berg to molecular biology have a range of significance well beyond that mentioned in the Nobel committee's announcement.



Sanger Gilbert Berg

The most impressive of the trio is undoubtedly 62-year-old Frederick Sanger for whom this is a second Nobel award. He is the second to win two Nobel prizes in the same field, the first being John Bardeen of the University of Illinois who won the physics prize in 1956 and 1972. Sanger received his first prize in 1958 for determining the chemical structure of insulin, the first protein to be sequenced, wherein he developed his own methods. The "fingerprinting" and "peptide sequencing" methods developed by Sanger opened up the field of protein chemistry and have led to many important discoveries. His colleague at the MRC Laboratory, V. Ingram, for instance, used 'fingerprinting' to show that the defective haemoglobin of persons carrying a gene for sickle cell anaemia differed from normal haemoglobin in a single amino acid. This was the first demonstration of the principle that genes control the sequence of amino acids in proteins, a basic tenet of molecular biology.

In the sixties, Sanger's interests shifted from proteins to nucleic acids. Robert Holley had then received the Nobel prize for sequencing transfer RNA. Sanger invented techniques which were much simpler than those of Holley and solved the sequence structure of 5 S RNA.

Finally Sanger turned to sequencing of DNA. He developed a series of methods, the most efficient being his latest which is beautiful in its simplicity. The method consists in growing a new DNA chain, using a previously denatured single-stranded DNA as a template with the help of the enzyme DNA polymerase. The reaction is carried out in four different batches, each supplied with radioactively labelled precursor nucleotides. The growth of the chain is terminated by adding a different nucleotide doublet (AA, GG, TT or CC) to each reaction. The growing chains in the tubes are arrested at a position where the terminating dinucleotide is incorporated. In each tube, all possible sizes of labelled DNA fragments, ending in a given base, are produced. Samples from the four reactions are subjected to electrophoresis on a gel. The electrically charged DNA fragments move to different distances according to the length of the fragment, the shortest chain moving the farthest. The gel is placed against an x-ray film which reveals the position of the radioactive fragments. Corresponding to the four reactions, there are four ladders. The presence of radioactivity in any rung in one of the ladders serves to identify the nucleotide at that position. Thus, starting from the last position, one can read the sequence of the entire molecule.

Using his own methods, Sanger analysed the complete sequence of the DNA virus 0X174 and made the remarkable discovery that genes were

not always spatially separate. He found that two strands in a segment of DNA were part of two different genes that were transcribed in opposite directions. Commenting on Sanger's work, another Cambridge Nobel laureate, Max Perutz, has remarked: "He certainly deserves two Nobel prizes". Considering Sanger's contributions to three major areas of molecular biology—protein, RNA and DNA—one is tempted to say three would not be too many.

Walter Gilbert, now Professor of Microbiology at Harvard, began his scientific career as a physicist. He read theoretical physics at Cambridge and then taught physics at Harvard about the same time as J. D. Watson joined the Harvard Biological Laboratories. Watson's group was, at that time, working on the isolation of the repressor, a molecule postulated earlier by F. Jacob and J. Monod of the Pasteur Institute, Paris, as an essential element in their theory of gene regulation. Watson induced Gilbert to join their experiments and, in 1966, Gilbert and Benno Muller-Hill succeeded in isolating the protein which acts as the repressor of the *lactose* genes in bacterium *E. coli*.

For several years, Gilbert has simultaneously taught theoretical physics and molecular biology at Harvard but the most striking feature of his research work is its chemical erudition. Gilbert's DNA sequencing techniques, for which he shares the Nobel prize with Sanger, are more chemical than Sanger's. Gilbert and his associate Maxam developed chemical methods which attack and break the DNA chain at a particular base. Four separate reactions are carried out, in each of which one of the four bases is destroyed. By carefully controlling the reaction, DNA can be broken just once at random positions, generating a series of fragments, all ending in a chosen base. The rest of the experiment is similar to Sanger's. The fragmented DNA is electrophoresed and the base sequence is deduced from radioautographs. The method works with either single-stranded or double-stranded DNA. Gilbert has made several other important contributions. Earlier, he had proposed an elegant model for the replication of circular DNA molecules. More recently, Gilbert's group has cloned the insulin gene of rat and transferred it to a bacterial cell which can synthesise this mammalian hormone.

Paul Berg's early contributions were in the area of protein and nucleic acid synthesis. The work which won him the prize is connected with recombinant DNA research, known in popular parlance as genetic engineering. Berg developed a method which allows two unrelated DNA molecules to be joined together. Using an enzyme called terminal transferase, a string of any chosen nucleotide such as AAAA can be appended to the end of a DNA chain. The second DNA is similarly extended with a complementary tail of TTTT. The tails function as sticky ends by which the two molecules can adhere and can be covalently linked. In one of his early experiments, Berg inserted DNA from an animal virus into a bacterial plasmid. Many regard Berg as the pioneer of genetic engineering because he was the first to splice together genes of different species.

Berg's group has carried out an extensive analysis of the DNA of the Simian virus SV20 and perfected the use of this virus as a tool of genetic engineering with mammalian cells. Recently he has transferred the haemoglobin gene with the help of SV40 to cells of the African green monkey.

Berg was among the first to warn the public against the possible dangers of genetic manipulation and is popularly known as the moving spirit behind the 'Berg letter'. He chaired the committee on recombinant DNA which was largely responsible for the imposition of safeguards for such research.

The impact of DNA sequencing and cloning techniques on the progress of biology has been truly dramatic and sequencing of DNA has turned out to be much quicker and easier than the sequencing of proteins. A number of genes have been sequenced and new facts have come to light. It had been widely assumed that the stretch of bases coding for a protein has to be continuous. It now turns out that the coding sequence in many genes is discontinuous, being interrupted by one or more 'intervening sequences'. The role of intervening sequences is still obscure. Many new insights into mechanisms of gene regulation have been obtained.

The recent progress in DNA research opens up unsuspected possibilities for understanding the nature and evolution of the living systems. These researches also have many practical applications which are now being widely discussed and explored. To borrow the words of Paul Berg, "Recombinant DNA puts us at the threshold of a new kind of agriculture and industry."

O SIDDIQI

Prof Siddiqi heads the Molecular Biology Group at the Tata Institute of Fundamental Research Bombay

Physics

THE 1980 Nobel prize in physics has been awarded to James Cronin of the University of Chicago and Val Fitch of Princeton University for the discovery of the violation of charge conjugation-parity (CP) symmetry in nature. In July 1964, Cronin and Fitch along with James Christenson, and Rene Turlay announced their startling discovery that the long-lived neutral K-mesons decay into two pi-mesons, the π^+ and π^-. This occurs once in about five hundred decays. The observation of this decay was very significant. It indicated the violation of CP-symmetry which had till then been believed to be an essential property of the world of elementary particles. The full significance of the breakdown of this symmetry, the so-called CP-violation, is still not clear. When achieved, it is likely to play an important role in understanding the nature of the interactions of elementary particles.

CP-violation refers to the violation of the symmetry obtained by the joint operation of charge-conjugation (C) and parity (P). We shall consider each separately

For every particle in nature, there exists an antiparticle with the same mass but having the opposite charge. (In some cases, like the photon, the particles and the antiparticles are the same.) For example, the antiparticle of an electron is the positron. They have identical masses but opposite charge. A law is said to be charge-conjugation symmetric (C-symmetric) if it is the same both for



Fitch



Cronin

the particle and the antiparticle Thus Coulomb's law, which says that two electrons repel and that the magnitude of the force is inversely proportional to the square of the distance between them, is charge-conjugation symmetric The same law applies to two positrons, too

CP-symmetry was found to be violated in weak interactions Weak interactions are interactions which lead to beta-decay in nuclei and elementary particles As an example, let us consider the decay of the negatively charged Mu-meson (μ^-) into an electron, a neutrino and an antineutrino It is found that the electron is emitted predominantly in a direction opposite to the spin of μ If this law were to be charge-conjugation symmetric, one would expect that the positively charged Mu-meson (μ^+) would decay into a positron, an antineutrino and a neutrino, with the positrons emitted predominantly in a direction opposite to that of the spin of the μ^+ Actually the positrons are emitted predominantly in the direction of the spin of μ^+, implying that the C-symmetry has been violated

Let us now consider P-symmetry Suppose we consider a law of nature which is derived from an experiment, will the law of nature be the same if we were to derive it by looking not at the experiment, but at its reflection in a mirror? If the law derived by looking at the image is unchanged, then the law is said to preserve the symmetry of parity (P-symmetry) One can again show that Coulomb's law, and other electromagnetic laws are indeed P-symmetric The weak interactions, mentioned earlier, do not obey this symmetry rule either

It was believed that all the laws of nature, including the weak interactions were CP-symmetric, that is, the laws were invariant under the joint operation of charge-conjugation and parity, even though they were not so under the separate operations of charge-conjugation or parity However, this had to be given up after the experiment which led to the observation of π^+ and π^- in the long-lived neutral K-meson

The neutral K-mesons are particles about 1000 times as massive as the electron There are two neutral K-mesons, K^0 and its antiparticle $\overline{K}^0$ A mixture of K^0 and $\overline{K}^0$ would behave as a mixture of two neutral particles, with two lifetimes—a particle with a short life, which would decay into two pions amongst several other possibilities and a long-lived particle for which the decay into two pions would be forbidden if CP-symmetry were strictly preserved in nature

Experiments done by earlier groups (Lederman's group in 1958, Neagu's group in 1961) had established the absence of such decays upto one part in 300 for the long-lived neutral K-meson Cronin and Fitch were interested in setting up stronger limits on the decay The experiment they conceived was done at the alternating gradient synchrotron in the Brookhaven National Laboratory, USA Much to their surprise they found that the decay to two pi-mesons occurred in about one in five hundred decays of the K-meson Soon these experiments were confirmed in several other laboratories The observation of the two pion mode of decay in the long-lived K-decay brought about the downfall of the CP concept as an exact symmetry law

If there is a CP-symmetry violating force, what laws does it obey? What is their strength? These questions have been occupying the physicists' minds ever since the discovery of the violation However, no conclusive answers have been found because there is no other situation where CP-violating effects have been discovered One theory which is consistent with all the detailed analyses of neutral K-meson decays is the so-called 'super-weak" theory put forward by Lincoln Wolfenstein of Carnegie-Mellon University in 1964, immediately after publication of the Cronin-Fitch experiment, where the CP-violating effects are assumed to be caused by super-weak interactions, whose strength is 1000 times smaller than that of normal weak interactions Not much else is known about this super-weak interaction" and no other effect of this has yet been observed This is because the effects, if they exist, are very small due to the strength being 'super-weak The recent discovery of mesons with a charm quantum number and a beauty quantum number has raised the hope that it may be possible to see CP-violating effects in their decays Such effects, if seen, would play an important role in determining the nature of CP-violating interactions

Further, there is also a theoretical result called the CPT-theorem, proved rigorously under very general conditions It states that the product of the charge-conjugation symmetry, parity and time reversal must be a symmetry for all physical laws. Here, time reversal symmetry (T) refers to the symmetry with respect to reversing the direction of time It states that laws should be the same even if time runs backward If CP-symmetry is violated, T-symmetry must also be violated in order to preserve the CPT-symmetry Several attempts have been made to observe T-symmetry breaking directly but it has eluded us so far The only place when T-symmetry is violated seems to be in the neutral K-meson decay and that too indirectly.

Very recently the CP-symmetry breaking effects have been considered to play a role in cosmology In our universe, matter seems to consist predominantly of particles rather than antiparticles The cosmologists use the CP-violation interaction to explain the predominance of matter over antimatter They suggest that these interactions played a dominant role just after the big bang, at the inception of the universe, when temperatures were extremely high, leading to a larger production of matter than antimatter

It is clear that the last word on CP-violating effects have not been said yet We can hope that substantial progress will occur in the near future

A native of Merriman, Nebraska, USA, Fitch obtained his doctoral degree from Columbia University in 1948 Since 1954, he is a faculty member at Princeton University and is now Cyrus Fogg Brackett Professor of Physics and chairman of the department

Cronin was born in Chicago and got his doctoral degree at the University of Chicago in 1955 He was at Brookhaven National Laboratory for some time before becoming a member of the Princeton faculty in 1958, where he remained until 1971

H S MANI

Prof Mani is in the Department of Physics Indian Institute of Technology Kanpur He works in the area of high energy physics

Economics

ECONOMETRIC model builders have been the butt of much serious criticism as well as light hearted banter, bordering on ridicule since the classic admonishment delivered by Keynes in 1937, on Tinbergen's pioneering effort in this field (Statistical Testing of Business-Cycle Theories') If only he (the model builder) is allowed



Klein

to carry on, he is quite ready and happy at the end of it to go a long way towards admitting with an engaging modesty, that the results probably have no value. The worst of him is that he so clearly prefers the mazes of arithmetic to the mazes of logic."

This attitude would have its adherents even today, though mercifully at least among professional economists, the weight of opinion seems to have tilted the other way, if the award of the Nobel prize to J. Tinbergen in 1969 and to L.R. Klein this year is any indication. Klein (60), whom the Nobel prize citation describes as "the leading research worker within the field of the economic science which deals with the construction and analysis of empirical models of business fluctuations", is currently Benjamin Franklin Professor at the University of Pennsylvania, USA, and chairman of the prestigious Wharton Econometric Forecasting Associates. Prof. Klein has had occasional forays into politics, with a tenuous association with the Communist Party of USA in the 1940s, and as chief economic adviser to Presidential candidate Jimmy Carter in the 1976 elections.

Klein started his research career at the US Cowles Commission in 1944. His major preoccupation during the three years he spent there was the analysis of business cycles in the US over the period 1921-41. This research (published in 1950 as *Economic Fluctuations in the US, 1921-41*) which was in Klein's own words devoted "to estimate laws of human behaviour in economic life" and "written in the spirit of Tinbergen's investigations", launched him as a full-fledged econometrician. Even more, the model struck a blow for econometrics by forecasting (correctly as it turned out) in 1946 that the US would not slip back into a depression when the wartime build-up ended, as most economists then believed. This basic model was later refined and elaborated by Klein, along with A. Goldberger and published in 1955 as *An Econometric Model of the US, 1929-52*. From then on, all of Klein's major efforts were channelised into developing increasingly more refined and elaborate econometric models, of which the Brookings Quarterly Model (done in collaboration with Duesenberry, Fromm, Kuh and others) possibly represents the logical culmination. Analysing the behaviour of the minutest facets of the US economy through computer simulations involving literally thousands of simultaneous equations, the model spewed forth forecasts of a myriad of economic variables. The US government, the Federal Reserve Board and several large corporations became increasingly interested in the possibilities of using largescale econometric models for forecasting and policy analysis. The recognition, in turn, stimulated the growth of such gigantic models as the SSRC-Brookings Econometric Model, the FRB-MIT-Penn Model and the MIT-Penn-SSRC Model, not to mention a host of other models in different countries all owing genealogical allegiance to the Brookings Quarterly Model.

Arthur Burns's disastrous flirtations with these models, in his famous 'fine-tuning' experiments as chairman of the Federal Reserve Board, revived some of the old suspicions regarding the practical applicability of these models. The last five or six years have witnessed a distinct cooling-off of the Establishment in many countries towards these models, especially because of the models' failure to successfully forecast the structural impacts of the oil crisis on national economies. Econometric model builders, all over the world, drowning their sorrows in computer print-outs, must have had their sagging spirits revived with the Nobel award to Klein at this opportune moment.

Klein's *magnum opus* will probably be the "Project Link" of which he was the main initiator in 1968. Project Link aims to link the econometric models of the various countries through their trade equations. So far, this project has encompassed only some of the major developing countries, but if the idea is pursued successfully, developing countries can also be brought within the purview of the model. If the model can be really made broad-based and effective, it can be used to demonstrate convincingly to members of developed countries or the OPEC countries the undesirable impacts on developing nations of some of their domestic and trade policies. The developing countries themselves can forestall some of these consequences by appropriate policy measures in the domestic and in the foreign trade sectors. If Project Link really succeeds, the world will agree that econometrics has come of age and the developing nations will have reason to remember Klein's name with gratitude.



"If this trend continues, we'll soon be celebrating the 50th anniversary of a 'No Nobel science prize'."

After graduating from the University of California at Berkeley in 1942, Klein obtained his doctorate from the Massachusetts Institute of Technology. He taught at Chicago and Michigan universities, and then spent some years in England, before returning to the US in 1958 to join the University of Pennsylvania.

D. M. NACHANE

Prof Nachane teaches quantitative economics at Bombay University

Brain Teasers

The Product Puzzle: I told my daughter to multiply two different numbers, and read out their digits. Later, I found that she had written them wrongly, interchanging the units and tens digits of each number. Surprisingly, the product (which was less than 600), was the same as she would have got, had she written them correctly. What were the numbers?

V. A. SHENAI

(Solution next month)

Solution to last month's Brain Teaser

Mr. None's primary perception is not smell, colour, touch or taste. So it is sound, which is Mr. Tongue's secondary. Mr. None's secondary is not smell, sound, touch and taste. Hence, it is colour, making smell Mr. Skin's secondary. Mr. Skin has taste as his primary, since it cannot be touch, colour, sound and smell. Finally, smell is the primary of Mr. Tongue, leaving touch as that of Mr. Eye. The entire set-up is as follows:

	Mr. Eye	Mr. Ear	Mr. None	Mr. Tongue	Mr. Skin
Primary	Sight	Colour	Sound	Smell	Taste
Secondary	Taste	Touch	Colour	Sound	Smell

Discovering science and technology for the village poor

FOR PERSONS concerned with science and its relevance to people, particularly in the villages, our experiences in Banda, a backward district in UP, might provide some food for thought. Our experiences suggest that socio-economic change is intimately connected with the scientific method. Rural folk have to understand that an alternative to their condition exists. And education, for them, must mean an understanding of how to bring about such a change and the role that science and technology play in it.

The conventional education of my school days, I found, had done little for the dry, one-crop farming area my village Terahi-Maufi represented. It had little irrigation facilities and people were chronically underemployed and ravaged by serious diseases. No villager who had done high school had come back to live in the village. Once they acquired their degrees, they fell for the fleshpots of the city; they paid only occasional courtesy visits to the village. My own future on completing studies, people predicted, would be no different.

To me and some others, however, science and technology loomed large in the general scheme of things. We believed that science was the organised knowledge of life, matter and energy, and that technology was the product of the inter-relation of these factors. To us, the scientific method essentially consisted in understanding a phenomenon by asking questions and resolving them through observations and reasoning. We felt that science—and technology based on the scientific method—were capable of changing the lives of people. But will I also fall for the kind of life predicted for me by the villagers? Nagging doubts assailed my mind as I shuttled between the city and my village home in my college days. Does higher education have any use? I would ask myself. Can the science we are taught help in solving the diverse problems faced by our villages? Can I do something useful for my society?

By the end of the sixties, Shobhana, my wife, and I had decided to seek solutions to these questions. We decided to take up a village project, with our own village, Terahi-Maufi, forming the focus. We aimed to make science and technology assist the poor; the key to progress, we had concluded, lay in education and in extending better production techniques to villages. Our immediate programme was to popularise science in the rural areas, to provide agro-industrial training to the rural youth and to extend to the villagers services related to education, health, hygiene and agriculture. Even though our focus was Terahi-Maufi, we decided to set up a district-level working centre at Atarra, a centrally located town in Banda, our home district in Uttar Pradesh. The Vigyan Shiksha Kendra (VSK, literally science education centre) was formally registered as a society in September 1973. In another six months we were fully immersed in the programme. And thus did we get started off on the problem-filled road we are still traversing.

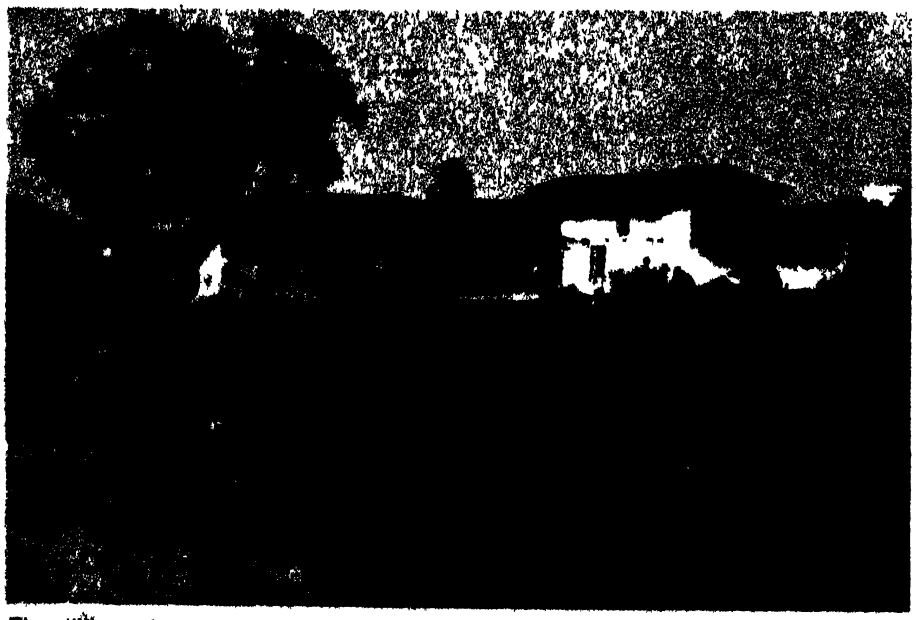
There was a mixed reaction to our decision of moving back to our village for community work. While a few friends and relations doubted its wisdom, we were actively supported by a number of scientists and educationists. Our visit to Kishore Bharati in Hoshangabad in Madhya Pradesh and our correspondence with V. G. Kulkarni of TIFR, Bombay and B. G. Pitre and C. K. Dixit of the Doon School (educationists who had pioneered the 'discovery approach' to education) provided the foundations of our educational effort.

The first programme which we took up in May 1974 was the school science project. We collected funds from a few well-wishers at the Atarra and Banda towns but a good bit of them came from a door-to-door collection from our own village. In July 1974 we arranged a 10-day science teachers' orientation course for ten teachers from five secondary schools in the area. A science workbook for the sixth standard was finalised and later introduced to 200 students in the five schools. Five follow-up meetings of the participating teachers organised later recorded the feedback and discussed new ideas VSK also conducted two examinations, one half-yearly and one annual, based on the discovery approach for these schools

We, however, soon came up against a number of problems We felt that the involvement of the state government and the school authorities was necessary for an effort of this kind to succeed. But we had not taken into account the complexity of our educational structure. We found that the educational background of the teachers and students and their relation with various government departments varied from school to school and from locality to locality. As an example: while teachers in the government Intermediate Colleges with B Sc and B Ed degrees taught science, in village schools a single teacher who had only passed his Intermediate College examination might teach a class all subjects including science. It was difficult to evolve a uniform pattern of training, contents of the workbook and examples and suggested materials.

Discouraging experience with state officials

Our experience with the government officials was also discouraging. Even though we received full cooperation from the district



The village calls Aau is a typical village in Banda district, UP



Discovering the world. Kits and work books help these girls to learn in a new way

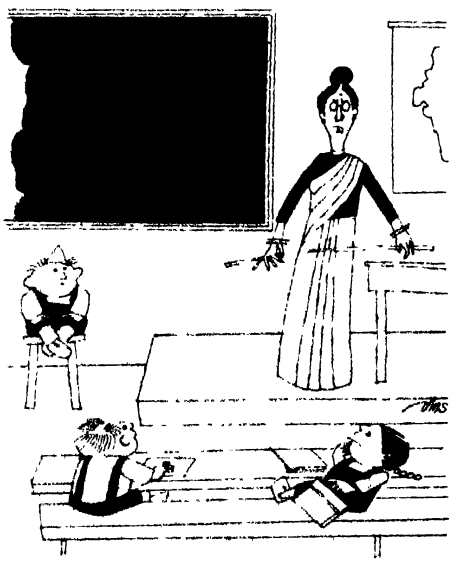
education department for our May 1974 orientation camp, we found that this cooperation was dependent on the individual inclinations of the officials. The transfer of a sympathetic official soon brought home to us that cooperation was not a matter flowing from policy decision. Even where we could get some cooperation, the rigidity of the school set-up and the teaching staff made it very difficult to introduce any innovations. For example, although we found from experience that the discovery approach was best served by allotting at least two successive periods to a subject, except for a few village schools, where a single teacher taught all subjects, we did not succeed in effecting a change.

Equally important, perhaps, we found that even teachers who were very enthusiastic about this programme in the beginning soon began to lose interest. They realised soon enough that our approach demanded more attention and time, besides their normal obligations in the school set-up. And yet there was no compensation or recognition from the government regarding their efforts. All this made us decide that we needed a school run entirely by people convinced of our approach and in a manner flexible enough to allow experimentation and innovation by both teachers and students.

With the setting up of an agro-industrial school in June 1975 we started another centre of the VSK at Aau village near Atarra. The object was to provide general education to the post-primary students of Aau and the surrounding villages, work out a new science curriculum based on the discovery approach, and also impart agro-industrial training to the youth of these villages.

We organised another orientation course for science teachers during July 1975 at the new centre. It emphasised the development of a curriculum which could be relevant to the needs of the village community. The experiments were planned with a view to using simple, cheap, and locally available materials. The orientation course, followed by a number of monthly follow-up meetings, allowed us to prepare a science workbook and to expose a larger number of teachers from Banda district to the discovery approach to science education.

Meanwhile, we were increasingly feeling the need to know more about our villages, and the people who we were trying to reach. During 1974-75 we had conducted a preliminary survey of the villages around Terahi-Maufi. In March 1975 we organised a village youth camp which discussed at length the rural situation and how the youth could transform it. The five-day camp included four long meetings and two days' field visits to the villages around Terahi-Maufi. This was one of the first opportunities for the local youth to get together and discuss the problems of the villages, their needs, and the available skills, resources and potential for solving the problems. The programmes evolved at the camp included those dealing with an agricultural services centre (which could provide machines and inputs like seed, fertiliser and advice to needy peasants) and the development of the local water resources (village tanks, wells and deep bores which could easily irrigate 2,000 acres of land in these villages).



..... I will not allow two consecutive periods

Experience with banks

These programmes needed help from the local banks. Our subsequent experience with the banks, and indeed our experience during the whole of 1976-77, brought about a change in our emphasis and priorities. The lead bank of the area which was set up for development financing had not served the poor entrepreneur. The small farmers and traders were openly abused by the manager and they did not dare to enter the bank. Our complaints to higher officials brought out a curious fact which, we found, was common to many backward districts. They told us that the present manager had been placed in this backward area as a punishment. He was now looking for another punishment—a transfer from the area! No wonder that he lorded it over the area and passed on his punishment to the people of Tindwari block!

We had also initiated a programme of non-formal education, mainly for the large number of non-school-going children in the Harijan locality of Aau village. In the evening, adults also joined the sessions. The programme brought us into contact with more and more sections of the people and their problems. We were obliged to respond to people's needs and often had to change our earlier programmes and conceptions. A case in point is our women's centre which slowly turned into a centre for young girls and children. We started out by trying to teach the women simple household crafts like sewing, knitting and toy-making. However, we found that while the middle-class women were occupied with their domestic work and the poorer women with field-

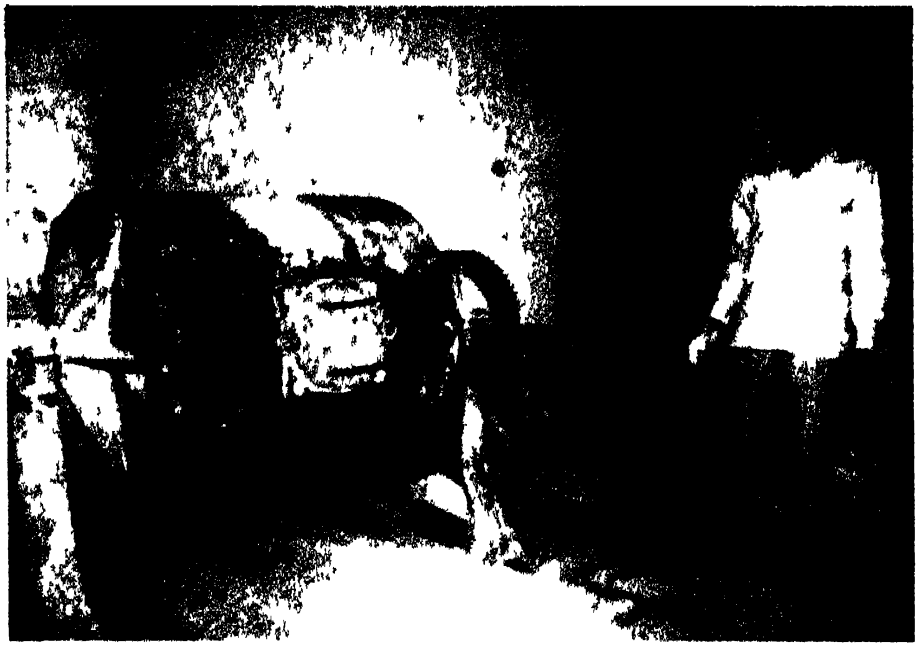
jobs, the only section who became interested were the young girls, along with their younger brothers and sisters

Slowly, we were coming to a sharper awareness that if people were to accept our programmes and were to be in a position to adopt and use them, we had to find out the needs of the different sections and their relative importance Only this could enable us to really plan out our work on a long-term basis Therefore, we immediately took up a socio-economic survey of 15 villages around Aau and Terahi-Maufi

In the 15 villages surveyed, we found that 61 per cent of the families owned less than two acres of land each, of these, 36 per cent were totally without land Caste was still an important factor, of the total cultivable land of 5,163 acres, only 261 acres were owned by scheduled caste families Of the families which faced a scarcity situation for more than four months, over 73 per cent belonged to the scheduled castes and around 20 to 22 per cent to the backward castes Indebtedness was high, but the landless and small farmers (a majority of whom are scheduled castes) had taken loans for essential purposes like food, medicine, and emergency needs Almost 50 per cent of all loans reported were for medical needs alone!

Obviously, the neediest sections were the landless and poor farmers, especially the scheduled castes and women Agricultural productivity is very low and landholdings uneconomic in most cases In villages land is an important instrument of power and in order that power be shared by all, the land had to be distributed This would lead to fragmentation which, however, could be overcome by collective farming assisted by easy credit input facilities, and service centres Only this could enhance productivity and at the same time generate enormous employment potential

Animal husbandry and traditional village trades were in a precarious position Craftsmen like carpenters, blacksmiths, potters, leather workers, and water bearers were giving up their trades and being forced to leave for the cities, many had to take to unproductive agriculture on small holdings Relevant transfer of technology for development in agriculture, animal husbandry, agro-industries and also health and educational services had to take into account all these needs Thus, it was necessary to create and develop the only possible industrial activity at the moment, that of primary processing of agricultural and forest produce, poultry and piggery This was also important if the landless and



Technology in service of the people The ASMOH (rice husk cement) plant is a new opportunity to process what would be lost as waste Picture shows the ball mill used for grinding the cement

poor farmers had to have an alternative outlet of employment which would supplement their incomes and increase their bargaining strength

The public health picture, too, was depressing For instance the primary health centre at Tindwari was hardly functioning due to the non-availability of medicines and the shortage and indifferent attitude of the staff The vaidyas who had previously met the people's medical needs to some extent had disappeared As a result, poor patients were forced to go to private doctors who charged exorbitant fees and this led to very high indebtedness We, therefore, felt a need to develop a basic health workers' team in the village Experience in India and elsewhere has shown that literate persons with short training courses can handle most of the common diseases and can identify conditions which need to be referred to a doctor

What we learnt from our discussion of the survey concerned the ways and means of implementing our programme We felt the need for organising the village poor who were socially split and exploited Unless the lower strata of society are socially organised and aware, no change could be expected in the rural scene Hence, we thought it necessary to develop a voluntary youth group which could catalyse this social process

Before taking any action, we had a number of discussions with other action groups, organisations, and a number of intellectuals at various seminars, meetings and visits From these exchanges we became convinced about the two important steps of the development process, that is (a) developing the conviction in the people that an alternative solution is a practical possibility and (b) educating them in the ways and means of achieving this solution Only when people began to solve their problems including those of social evils through group meetings mass struggles and free and rational discussions could both these conditions be fulfilled

By June 1978 we handed over our school at the Aau village to the village committee and started working out our ideas Our first step was the initiation of a youth organisation Gramin Yuva Sangathan (GYS) It provided the poor farmers with scientific advice and encouragement for increasing their productivity It also tried to organise the youth for learning alternative skills and setting up small industries At Tindwari we were unsuccessful in getting any help for this activity from the leading bank in the area However, the Harijan youth of Aau, who were now much better organised, could generate enough pressure on the nationalised bank at Atarra, and 14 out of 19 applicants from the landless group were granted loans

Relevant technology

In search of a relevant technology, we concentrated on projects like using polyester yarn for handlooms, improving dry-land agricultural practices, and developing a rice-husk cement plant Work on using polyster yarn for handlooms is in progress and is expected to net Rs 300 pm per head Of course, competition often creates

problems for these small units. A Rural Technology Centre is under development at Atarra where new techniques and implements will be developed, popularised and sold with good after sales service. The rise husk cement plant (ASMOH plant) uses rice husk ash (RHA), an abundant waste around Atarra, to develop a useful cementing material. A plant of ASMOH has been set up at Aau in consultation with and encouragement from the Director and Prof. P. C. Kapur of the Indian Institute of Technology, Kanpur. The pilot plant cost about Rs. 22,500. Much experimentation and many trials during 1976-79 have improved the quality of ASMOH and it now meets all the requirements of a good cement. A production-cum-training unit of ASMOH is under construction at Atarra, and the pilot-plant at Aau has been closed.

Organising the landless farmers

Our most important and educative work in the recent period, however, is that of organising landless and poor farmers. Around September 1978 some landless families from Aau started meeting every week to discuss their plight and to improve it through group efforts. They have by now succeeded in starting some economic activity with finances from the bank at Atarra mentioned earlier. They could also successfully struggle against a big landlord of the village.

Our work in Terahi-Maufi started in April 1979 when 10 landless Harijan families began meeting every Tuesday to discuss their problems. The first issue which attracted them was a thresher machine which had been bought by a landlord of the area and was being hired out to several farmers of the village for wheat-threshing. The threshing time used to last 15 days to a month and accounted for a substantial part of their income; with the thresher, the job could be handled by very few labourers and the threshing time was reduced to less than four days.

This was just a beginning. Later, participation slowly increased and issues relating to their work, work-conditions, wages, ill-treatment from landlords and land-reforms began to be raised. The group was heterogeneous in nature—some were ploughmen, others contract labourers and share croppers and still others were casual labourers—and this created some difficulties. We did not ourselves propose any economic programme or change in their work-pattern. We thought it necessary to have a united group before taking any further step. While each person was free to handle his own problem, the meetings were held to discuss their common and, sometimes, individual problems.

"Poor Man's Bank"

Soon the idea of a grain bank, popularly known as "Poor Man's Bank", was proposed. The grain bank, which was built up of contributions of foodgrains from members, could give interest-free grain loans to its members. It started with five quintals of foodgrain contributed by 15 Harijans and the VSK. Some additional help came from an outside agency, OXFAM, but that was kept as a revolving fund. This bank was soon to become important to its members during the drought that followed; it helped several others also with food, fodder, clothing and blankets and also freed a bonded labourer by paying off his debts to his landlord.

By September 1979, the drought situation had become acute and it hit the Banda district very hard. The united action of the Harijans and the landless brought sufficient pressure on the Block Development Office to keep the entire population provided with fairly continuous earth-work and timely payment of wages. With the drought the Tuesday meetings began to become representative mass meetings of the rural poor to decide upon their course of action. The old group of 12 conscious Harijans had to prepare hard for these meetings in advance; hence they began to have their own meetings on Mondays.

The sudden changeover to mass activity, exciting as it was, also brought forth many new problems. A whispering campaign was started against the VSK at the initiative of the big landlords in the area who smelled trouble for themselves in these mass gatherings. We publicly and voluntarily withdrew from the mass meetings, providing only the lantern, registers and sometimes assistance in writing for some time. A group leadership enjoying the confidence of the people could then emerge.

By January 1980, the drought worsened, and the entire rural population including the government officials, and the block, panchayat and school staff was drawn into the food-for-work projects which had to be opened everywhere. Enormous funds, grains and contracts became available. There was also a corresponding increase in employment, and many thousands all over the district had to take up earth-works. This also led to corruption becoming rampant and commonplace.

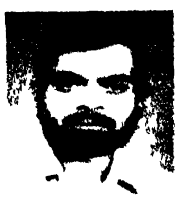
The VSK fought against corruption. But the drought was so harsh that even some of the active educated youths of the village and some village pradhans were tainted by it. Investigations of complaints were foiled by buying over the witnesses. Large food stocks were cornered.

It was a frustrating experience. The atmosphere became so charged with doubts and distrust that participation in the Tuesday meetings became quite low. The atmosphere did not improve until June which brought rains and relief. The issue of land again became important. The weekly meetings and participation of most of the Harijans has started again in full swing. But this year, it is the floods which are causing problems.

From our work, our changing emphasis and our opportunities of exchanging experiences and ideas with other groups and persons, we have perhaps learned much more than the labourers who participated in our programme. We had started out with the idea that a rational approach to science could help traditional society to get away from superstition and blind beliefs and put it on the road to progress and development. But we have in the process found that we cannot stand indifferent to the socio-economic evils and practices or to the interests which act as a drag on progress.

We have encountered at first hand the problem of the fragmentation of the rural poor and their consequent powerlessness and apathy. We have also found that science and technology as knowledge and tools for changing the human condition have been cornered by a small privileged section which jealously guards its privileges, including the effective use of science. We have found that to make science a reality for the mass of the rural poor, we have to organise them to fight for the betterment of their conditions and fight against oppression and oppressors. Perhaps our situation and our problems, and the ways and means of our solution were special. However, we believe that here is sufficient material for thought for persons concerned with science and its relevance to people.

BHARTENDU PRAKASH



Dr Bhartendu Prakash obtained his Ph D from Allahabad University and was senior Post-doctoral Fellow at the Indian Institute of Technology, Kanpur. His field of research was solid-state chemistry and the dielectric studies of organic systems. He is presently Convener of the Vigyan Shiksha Kendra, Atarra in the Banda District of UP

Simple husk-fired furnaces

"WASTES" like rice husk, groundnut shells, paddy straw, cotton stalks, etc are produced while processing agricultural produce. But these wastes are also renewable, agriculture-based fuel resources. The annual world production of rice husk and paddy straw can be put at about 70 and 700 million tons, respectively. Of this, Indian production accounts for 14 and 150 million tons, respectively. The world production of groundnut shell is about 7 million tons, of which India contributes 2 million tons. Along with materials like cotton stalks, corn cobs and bagasse, the total amount of agricultural waste in India may represent an annual energy equivalent of about 24 million tons of coal, or about Rs. 465 crore worth fuel at its cheaper price.

No wonder, then, that the energy crisis has given a new status for materials like rice husk; from being a disposal nuisance, they are now being seriously considered as an alternative fuel. Rice husk and other agricultural wastes may not be able to replace coal and oil, but they make a good fuel for all drying purposes. The modern rice processing industry requires heat for drying raw or parboiled paddy and also for generating steam which can be used for parboiling and to provide power for rice mills. It is an attractive proposal, therefore, to use agricultural wastes as fuel in processes like parboiling and drying.

Table 1 on page 51 gives the average composition of various fuels. Rice husk agricultural waste compares well with sources like firewood. Even compared to coal, weight for weight, they contain at least half the amount of carbon. One hundred kg of rice husk requires, on an average, 481 kg of air (about 373,000 litres) and yields 563 kg (about 430,000 litres) of products of combustion. The ash content of rice husk is rather high but this does not mean a lower proportion of combustibles.

But the problem with the use of agricultural wastes as fuel lies in the firing. Coal, or even firewood, is compact material, and so coal furnaces can also be compactly built. Being fine and very light, agricultural wastes create problems of proper combustion; this calls for special furnaces to use these materials efficiently. The Rice Process Engineering Centre (RPEC), Indian Institute of Technology, Kharagpur, has designed three such furnaces.

Horizontal cyclone furnace: This furnace, coupled with a steam generator and paddy dryer, can form an efficient system. The cyclone furnace lets in a mixture of husk and primary air in the conical end of the furnace and secondary air near the point at which the furnace widens into its cylindrical shape (Fig.1). The air-husk mixture and the secondary air are let in tangentially, which creates a cyclone-like motion of the mixture and, with sufficient velocity at the entry point, keeps the entire mixture well mixed and moving towards the other end of the furnace.

The inside wall of the cyclone chamber is lined with refractory bricks and fire clay. The cylindrical chamber which forms the cyclone furnace (1.1 m diameter x 2.3 m height) has a cone at one end, known as the cyclone tip, and a re-entrant throat at the other end. The cyclone tip has a hinged door with a collar to sit in the cone opening and is made air-tight with three chamber bolts. At the centre of the hinged door is a smaller opening with an open-shut arrangement to enable both the firing of the furnace and a quick glance at the inside burning process. The husk is introduced through a 10 cm diameter pipe from a primary blower delivering 6,000 litres per minute at 100 mm water gauge pressure. The secondary blower has a rated capacity of 10,000 litres per minute at 185 mm water gauge pressure.

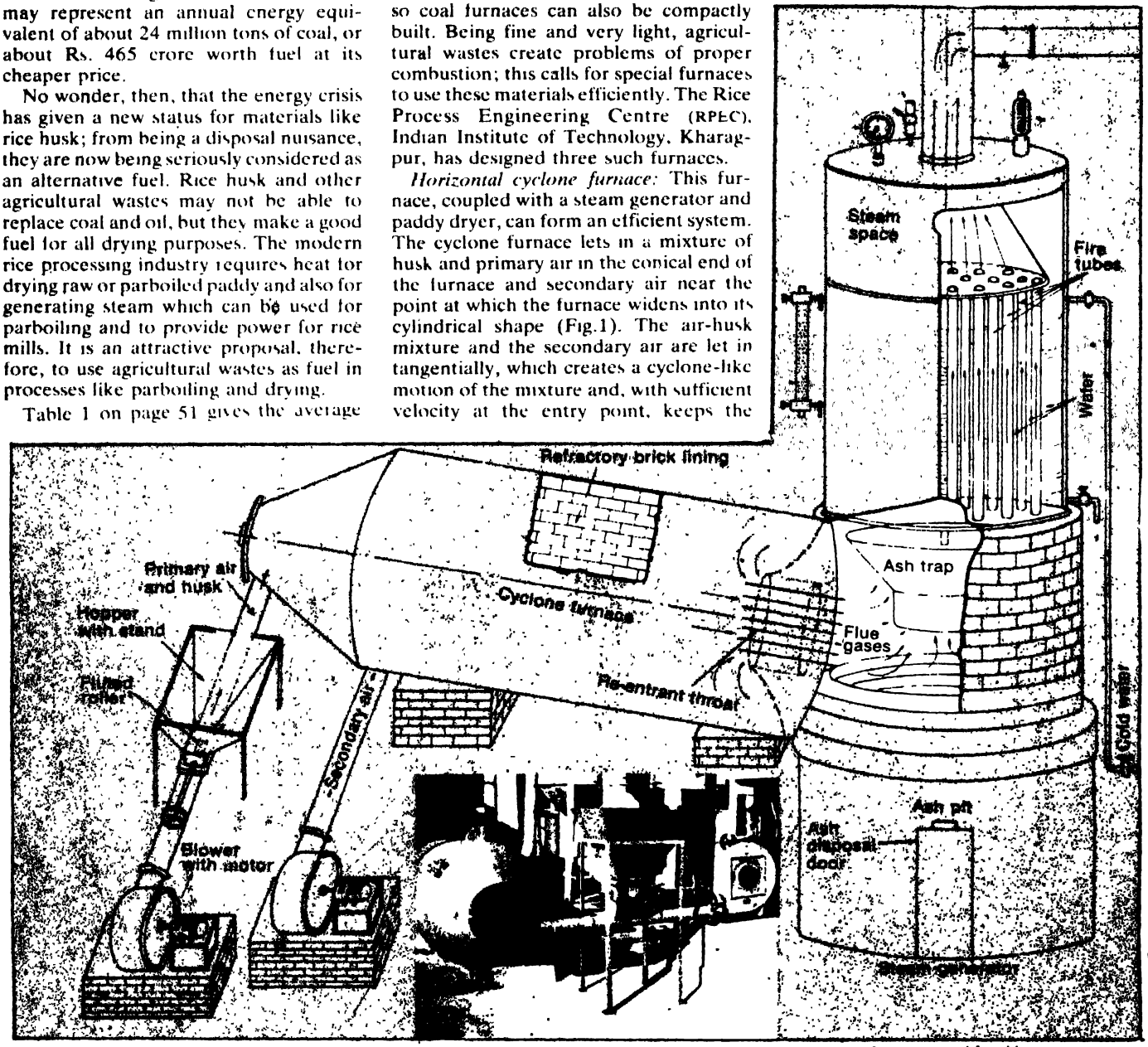


Fig.1 Schematic view of the horizontal cyclone furnace and steam generator. Inset photograph shows the furnace and feed hopper

The husk is introduced into a hopper and a fluted roller placed in the hopper lets the husk into the primary air from the blower. The re-entrant throat at the other end of the cyclone furnace ensures turbulence at the fag end of the cyclone and prevents collection of unburnt husk or ash in the furnace. The furnace is first fired by paddy straw. After the feeding of husk is started, the blowers are switched on one after the other. In our tests, the highest furnace efficiency of 78.5 per cent occurred at a husk feed rate of 125 kg per hour with an excess air of 53.4 per cent. The flue gas analysis showed almost complete combustion

The steam generator was designed to generate 200 kg per hour of steam at a pressure of 5 kg per sq cm and sufficient to parboil one ton of paddy per hour. The boiler exhaust was coupled with a grain dryer of 1.25 tons holding capacity. The highest combined furnace-boiler efficiency of 37.5 occurred at the same feed-rate of 125 kg per hour but with an air-flow rate of 12,740 litres per minute, which also gave the best overall efficiency (74.55 per cent) for the complete system

The furnace has also been operated successfully and efficiently with groundnut shell and paddy straw instead of rice husk. The fabrication costs of the cyclone furnace and steam generator were Rs. 3,000 and Rs. 5,500, respectively. The total operating cost of the cyclone furnace and steam generator worked out to about Rs 6.27 per hour for steam generation and drying. Though the pilot plant in operation is used only for steam generation, it can be modified to even generate power for a rice mill

Grate type furnace for paddy drying: The grate-type furnace is quite good for drying paddy and other crops. This furnace, simple in design, is meant for units which do not involve steam generation. It matches a dryer of 1.25-ton capacity.

The box-type furnace (Fig.2) is equipped with a grate which can be inclined at 40, 45 and 50 degrees and consists of cast iron bars arranged in a staircase fashion. At the bottom of the inclined grate is a horizontal revolving grate which periodically disposes of the accumulated ash. A curtain wall throughout the width of the furnace at the end of the horizontal grate prevents any fly ash or unburnt husk from

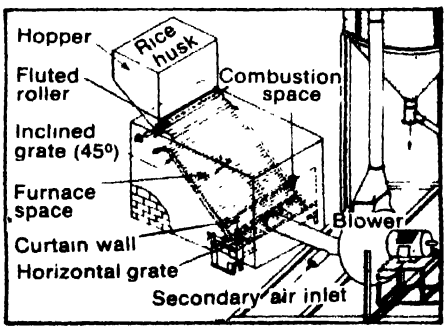


Fig.2 Schematic view of husk fired inclined grate furnace.

Fuel	Per cent by weight			
	Carbon	Hydrogen	Ash	
Firewood	35.0	4.3	0.7	
Peat	30.9	3.2	6.6	
Straw	36.0	5.0	4.7	
Oat	41.0	5.2	6.3	
Corn	38.0	4.8	1.6	
Rice husk	38.2	5.0	17.4	
Groundnut shell	45.9	5.4	3.9	
Coal	70.8	5.1	10.4*	
Liquid fuel	84.8	12.7	—	

*Moisture ash

going into the outlet along with the hot gases.

The husk is fed into the furnace at the top of the inclined grate by a fluted roller placed at the bottom of the feed hopper. The husk spreads in a thin layer on the steps of the grate and slides down by its own weight, and combustion occurs at the same time. The air for combustion is sucked in through the opening for feeding husk and partly through the grate openings. No extra power is required for this. When the flue gas temperature is to be reduced for different requirements, additional air is introduced through the secondary inlet until the required temperature is reached.

During tests, the furnace was coupled with an RPEC recirculatory paddy dryer. The highest furnace efficiency of 64.5 per cent occurred at a feed rate of 14.25 kg of husk per hour with 286 per cent excess air. Carbon monoxide was totally absent in the flue gas. The flue gas, therefore, was safe for drying. The grate furnace is presently being used by more than 30 mills in India.

Vertical pressurised combustor: This combustor can develop high flame temperatures of the order of 1,400°C from simple rice husk. The design (Fig.3) is simple, and consists of a vertical chamber of one-metre diameter and two metres height. The top end was closed with a mild-steel sheet and a 10-cm diameter duct fed husk and air into the combustor from a blower. The lower end of the chamber formed a conical bottom, tapering to an outlet of 25-cm diameter. A perforated plate at the outlet just below the conical bottom checks the burnt ashes inside the chamber.

The combustor first gassifies the husk. This is followed by combustion of the gaseous substance to give a flame. The furnace can operate with an efficiency as high as 80.5 per cent at a feed rate of 40 kg of husk per hour and an air flow rate of 2,830 litres per minute.

As the figure and photograph shows, it can be very efficient under-feed type of heater. Other wastes like paddy straw and groundnut shell, along with rice husk, also burn efficiently and smokelessly. However, the vertical furnace has one drawback; it needs intermittent ash disposal and is not very suitable for continuous operation. The horizontal cyclone furnace, though it has a lower temperature, is the more suitable design for continuous operation.

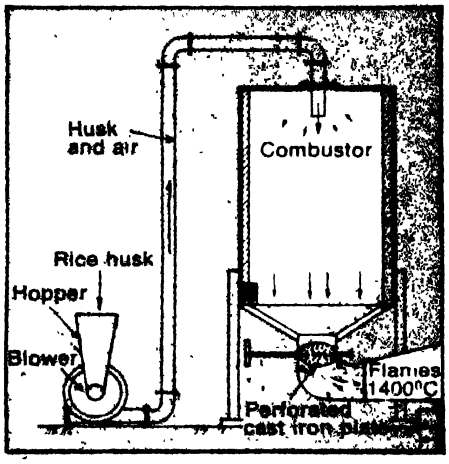


Fig. 3 Schematised view of pressurised husk-fired combustor Photograph below shows the high temperature flame



RAJVIR SINGH

Dr. Singh is a research engineer at the Rice Process Engineering Centre, Indian Institute of Technology, Kharagpur.


Come Alive
with
NESCAFÉ®
Nestlé
NESCAFÉ
instant Coffee
Largest selling
instant coffee
in the world
the only instant coffee
made from 100% pure coffee
CAS-FSL-281

... there is antimatter in the universe

"How can you say that Nature loves symmetry when God has given us only one heart that is situated on our left side? True, there are some people with the heart on their right side, but their number is negligible." So said Prof Abdus Salam, last year's Nobel laureate in physics, during a talk delivered about two decades ago at the Tata Institute of Fundamental Research, Bombay, on the non-conservation of parity in particle physics. "If Nature loves symmetry always", he added, "God should have given us two hearts or kept one at the centre."

Antiparticles were proposed by P.M. Dirac about four decades ago on the basis of the principle of symmetry existing in nature. An atom of any substance is supposed to be made up of a nucleus consisting heavy and positively charged protons and neutral neutrons round which the light and negatively charged electrons revolve. Although there is perfect symmetry between the positive and the negative charge, scientists were puzzled why there should be only light particles with the negative charge and only heavy particles with the positive charge. This spoils the symmetry observed in nature. Such deliberations led to the discovery of the positron (a particle with the same mass as an electron but positively charged) in cosmic rays in 1932 and the antiproton (with the same mass as a proton but negatively charged) in 1955 in particle accelerators. These discoveries were triumphs for the aesthetic-philosophical aspects of physics.

What happens when these particles of opposite charge are brought together? If one electron and a positron collide they would 'annihilate' one another; their total energy would get transformed into gamma rays. By total energy, we mean the energy equal to the sum of the masses of the electron and positron plus their kinetic energy.

When an antiproton at rest meets a proton, they not only annihilate each other, but during this process they give rise to many other unstable extremely short-lived particles called mesons which disintegrate spontaneously within a very short time, giving rise to other type of mesons, which in turn disintegrate to positrons and electrons. These processes also cause the emission of photons (gamma quanta) and neutrinos (uncharged particles of negligible mass). The usual end-result of a proton-antiproton annihilation at rest is one or two electrons, the same number of positrons, and gamma and neutrino radiation. If these electrons and positrons later collide, there is another annihilation which results in the emission of further gamma radiation.

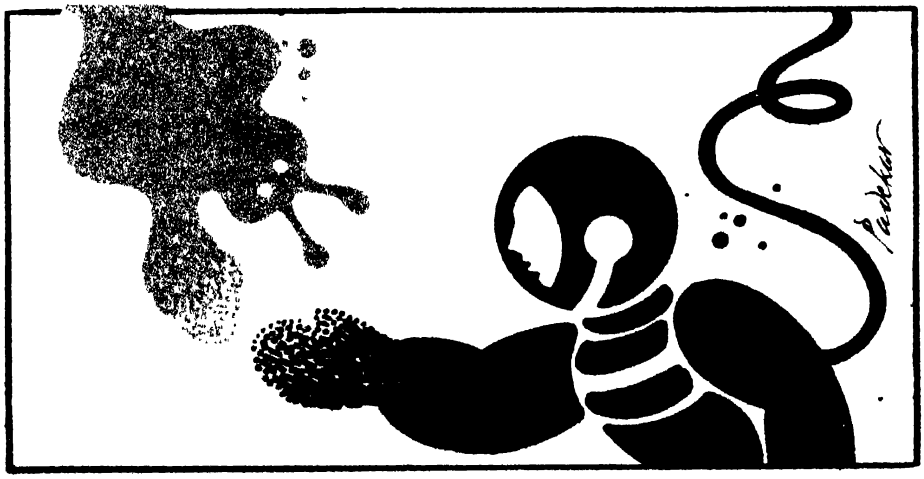
The antiproton at rest has an energy (its equivalent of mass) of about 900 MeV and the proton at rest has an energy of another 900 MeV. Thus, if we assume negligible motion by the particles prior to collision, we have an energy of 1800 MeV of which about 900 MeV is generated as neutrino radiation and 600 MeV as gamma radiation. The remaining 300 MeV is shared by electron-positron pairs. On the average, 1.5 electrons and 1.5 positrons are produced for each proton-antiproton annihilation. In other words, for every two proton-antiproton annihilations, three electron-positron pairs are produced.

What happens when an antiproton and a positron are brought together? On grounds of symmetry, we can presume that the same thing happens as when a proton and an electron are brought together—they form an atom. The positron will revolve round the antiproton in the same stable (Bohr) orbit, and when a positron jumps from one orbit to the other, it will emit light of the same frequency as an electron would do round the orbit of a proton. Thus we can say that these two would form an 'anti-hydrogen' atom, having the same properties as that of ordinary hydrogen. Extending the argument, we can deduce that two antiprotons and two positrons would form an 'anti-hydrogen' molecule analogous to the hydrogen molecule. And if we could produce such molecules in sufficient quantity, we could produce antihydrogen gas, which would condense to liquid antihydrogen at —252°C.

We can continue this exercise, and make an antiproton and antineutron to form an 'anti-deuteron' just as a proton and a neutron combine to form a deuteron. Anti-deuteron has been produced in accelerators artificially. Similarly, eight antiprotons and eight antineutrons form an antioxygen nucleus, from which, along with positrons, we can get and make a large number of anti-oxygen atoms. These can combine with twice the number of antihydrogen atoms to give us anti-water—a liquid which boils at 100°C and becomes 'antisteam', or freezes at 0°C and becomes 'anti-ice'.

The only difference between water and antiwater is that a mixture of the two would generate tremendous energy—it would explode like a bomb. The antiprotons, antineutrons and positrons in the antiwater would annihilate ordinary water's protons, neutrons and electrons. By being annihilated and at the same time annihilating an equal amount of matter, it would release many times as much energy as a hydrogen bomb of the same weight. Antihydrogen, antioxygen, and anti-carbon molecules may combine together to form complex organic compounds. Together with antinitrogen and several other elements, they can form the whole range of chemical elements which are the basis of organic life.

It should be possible to build up antimatter from antiprotons, antineutrons and positrons. If we have the resources to collect somewhere in outer space about 10^{57} atoms of antihydrogen partly mixed with miscellaneous anti-elements, we can form an 'antistar' very much like our sun. At its centre, thermonuclear processes



What should be the right question to ask if you come across an inhabitant of a different galaxy before shaking hands with him? This year's physics Nobel prize discovery (see p. 41) provides the answer. The long-lived state of a mixture of neutral K^0 meson and its antiparticle, K^0, violates CP conservation in its decay. In the more-common case, the long lived-state decays into a negative pi-meson, a neutrino and a positron. Whereas less commonly it decays into a positive pi-meson, an anti-neutrino and an electron. So ask the alien, if the lepton (generic name for electron or positron) produced in the decay of the longest lived state of a mixture of K^0 and $\overline{K^0}$ is the same as the particle that orbits the nucleus of the simplest atom. If he says yes then you certainly shouldn't shake hands with him. He is made-up of anti-atoms. By shaking hands with him, you will dissolve your hand into ghostly gamma rays

"While I was perfecting my square drive, Palmolive was perfecting my shaving."

says Sunil Gavaskar





Palmolive has SGL-4 to give you rich, moisturized lather for the closest, smoothest, most comfortable shave yet.

Palmolive shave cream stays moist throughout your shave. Its rich, creamy lather softens the toughest beard. Improves razor glide. To make your shave closest, smoothest, most comfortable.

Choose your kind of shaving pleasure from Palmolive

Palmolive De-Luxe Lather...
the creamy smooth lather and bold masculine fragrance for real shaving pleasure.

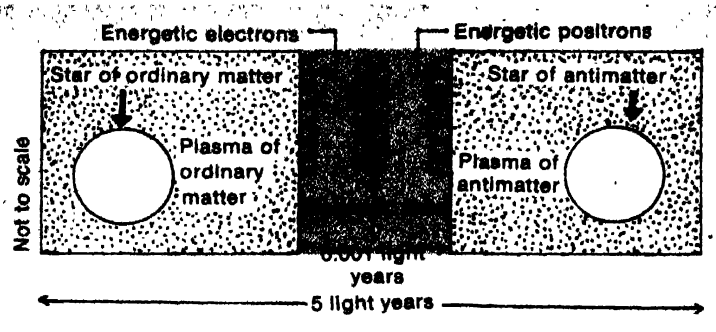
Palmolive Lemon-Fresh...
with a lemon-fresh tang for a refreshed after-shave feeling.

Palmolive Menthol-Cool...
dashingly cool fragrance and skin-cooling menthol.



Palmolive—the choice of successful men the world over!

PSC.G.5.79



The Leidenfrost layer is the annihilation layer separating ordinary matter and antimatter. It consists of a mixture of energetic electrons and positrons that give radio music (in magnetic fields) which can be heard by radio telescopes.

would be generating energy and if its chemical composition were analogous to the sun's, it would radiate light with the same spectral lines as that of sunlight. A collection of antistars could form an 'anti-galaxy', and so on.

Let us now see what would happen if antimatter existed in several parts of the universe. It is fairly clear that there is no naturally occurring antimatter on the earth (except that created by cosmic rays in the atmosphere). If there were any, when it came into contact with matter, it would create an explosion. W.F. Libby of C-14 fame, who passed away recently, had suggested that the meteor, which fell in Siberia in 1908, consisted of antimatter. His suggestion has not been disproved, but neither has it been proved

If there were any antimatter in the solar system its detection would be quite simple and straightforward. The most rudimentary detector would suffice. If the detector disappeared it would prove that antimatter existed. Space probes have landed on the Moon, Venus and Mars without being annihilated. They provide evidence that these bodies of the solar system are made up of ordinary matter. The sun blows out a 'wind' consisting of an extension of the solar corona and emits solar cosmic ray particles occasionally. Had the solar wind and energetic particles emitted by the sun consisted of antimatter, they would have annihilated the space probes that came into contact with them. If any of the planets in our solar system were made up of antimatter, interactions of solar wind on its surface would make them the strongest gamma ray sources in the sky, which they are not. Therefore, we can conclude that the entire solar system consists of only matter.

It is believed that the solar system was formed from the collapse of a gaseous presolar nebula. Any antimatter initially present in the nebula would have been annihilated long before any solid bodies condensed, because the annihilation time is much shorter than the collapse time. If substantial amounts—nearly half of the total presolar nebula were of antimatter—it is quite likely that nothing would have survived to form the solar system.

Matter and antimatter cannot survive in the same galaxy in the form of a mixed gas component. If they did, then the galaxy would shine in the annihilation gamma rays since a third of the total energy (600 MeV) is carried away by the gamma rays. From observations of galactic gamma ray background, one can set an upper limit of about 10^{-15} for the fraction of antimatter to coexist with matter in interstellar space. However, if antimatter were separated from matter during the early phase of formation, then they may not come into direct contact with each other. Stars and antistars could then be formed out of these regions of matter and antimatter. However, the light emitted from a star and an antistar would be alike. There is no way of distinguishing them from the radiations they emit, be they light waves, radio waves or gamma rays.

If the space between the stars were completely empty, their light could not tell us whether or not the stars consisted of antimatter. Indeed, many of the stars, perhaps half of them, might be formed of antimatter. However, it so happens that the space between stars is not empty; it is filled with thin magnetised plasma. Plasma from space may fall in towards a star, or stars may eject plasma into surrounding space. If antistars existed, they would eject plasma into antimatter and their surroundings would be the scene of interaction between ordinary matter and antimatter.

The problem has been discussed by H. Alfven of Sweden. When the ordinary plasma and antiplasma intermix, annihilation accompanied by generation of enormous energy ensues. As the border layer heats to a very high temperature, the annihilation gets attenuated due to a phenomenon he calls "Leidenfrost phenomenon". The annihilation in this layer may then proceed slowy, because the rate of annihilation need not be more than necessary to maintain the layer. In due course, a Leidenfrost layer may form to insulate the ordinary plasma from the antiplasma. Calculations show that a Leidenfrost layer in space can be very thin by cosmic standards. Under certain conditions, it may not be more than 1/1000th of a light year (about 10^{+15} cm) across—enough to keep the ordinary matter and antimatter effectively separated from one another.

Alfven showed that the Leidenfrost layer consists essentially of positrons and electrons, the charged products of the annihilation process, and they produce radio waves in a magnetic field of the order of 10^{-5} gauss. So one can look for the radio emission from this layer besides the annihilation gamma rays. A mixture of ordinary matter and antimatter associated with an ordinary star and an antistar should manifest itself by the emission of radio waves and the radio star may indicate the presence of antimatter. However, radio emissions from stars may have other explanations.

We can satisfy the demand for symmetry in the universe by following the various paths of supposition:

1. We may suppose that antimatter is present in some remote corner of space unknown to us, and that the whole of our galaxy consists of ordinary matter.
2. We may suppose that every second galaxy is made up solely of antimatter.
3. We may suppose that the remotest half of our galaxy consists of antimatter and the nearest half of ordinary matter.
4. We may suppose that every second star in our vicinity consists of antimatter. This is carrying the symmetry requirements to its extreme.

The last possibility can however be ruled out from the following considerations: (1) Every alternate star is not a radio star. (2) In the case of an antistar, its motion through interstellar medium would accrete interstellar matter, which upon annihilation will produce gamma rays. One can calculate the rate of gamma ray production. If every alternate star were an antistar, the galaxy would shine brighter in gamma rays than is actually observed.

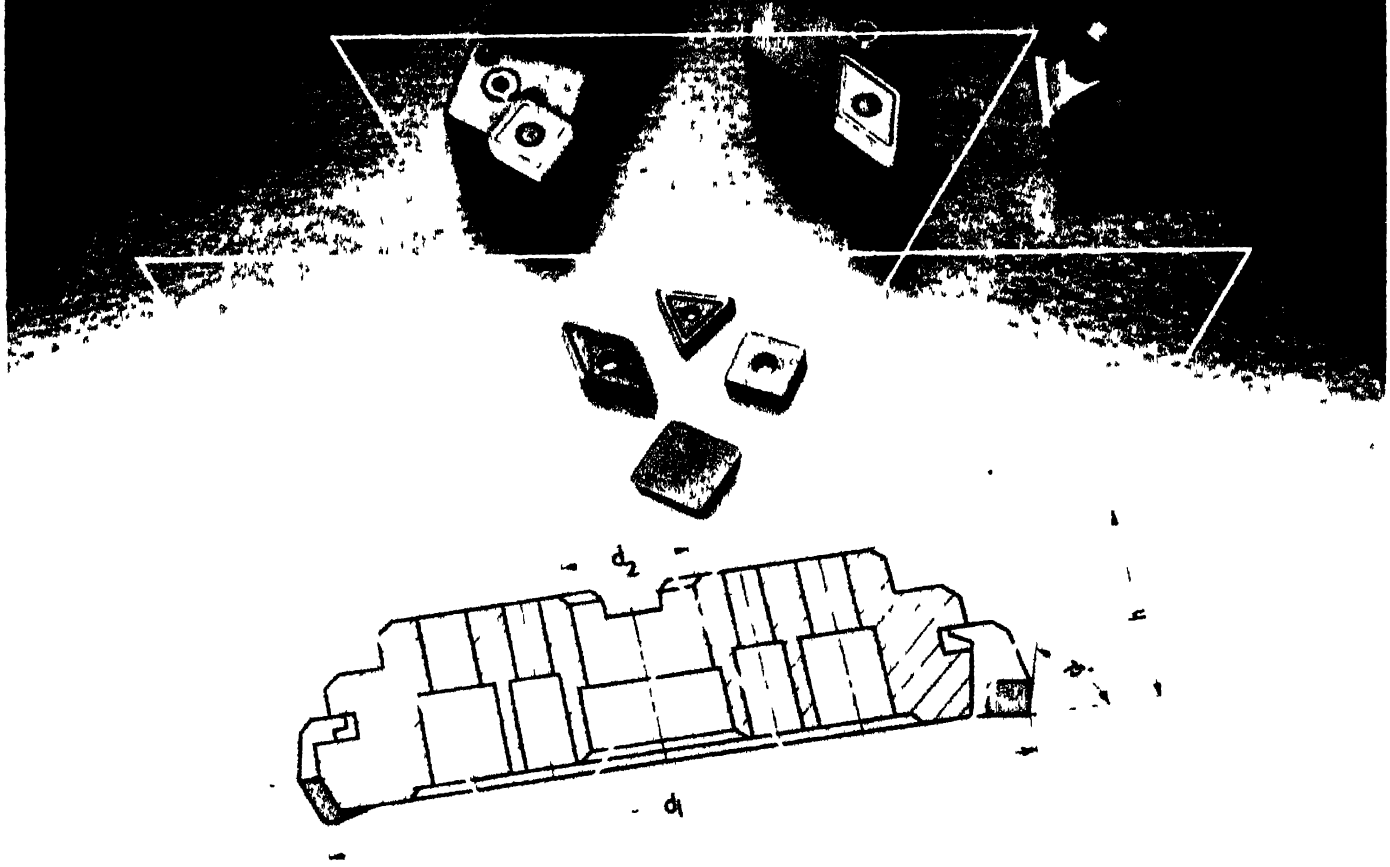
Whether the space between stars (the interstellar medium) consists of matter and antimatter can also be tested using Faraday rotation. Polarised light passing through interstellar medium will have its plane of polarisation rotated through an angle that depends on the square of its wavelength. The rotation also depends on the number of positrons and electrons in the line of sight; should there be a comparable number of matter and antimatter clouds, there will be a null Faraday rotation along the line of sight. This, however, is not observed, suggesting that interstellar matter does not consist of equal amounts of matter and antimatter.

There is no positive evidence yet for the existence of antimatter in the universe. The recent experimental observation of antiprotons in cosmic rays (SCIENCE TODAY, December, 1979 p. 34) is consistent with its secondary production in the traverse of cosmic rays through the galaxy. There are no antinuclei observed so far in cosmic rays. Their detection would give a definite evidence for the existence of antimatter in the universe. Even in the laboratory, though only anti-deuteron and anti-He^3 *nuclei* have been produced, no antiatoms have been produced. Technologically, their production is a formidable task.

N. DURGAPRASAD

Dr. Durgaprasad is Reader, Solar Physics-Cosmic Rays Group, at the Tata Institute of Fundamental Research, Bombay.

When our technologists
finally married
tungsten carbide to
tool engineering
they did not wait
for a celebration...



They gave us the tools instead.

Superior tools at that. Tools that have stood rigorous quality control tests. Tools that have proved in performance. With unprecedented cutting speeds and cost savings

Tools that bear the class of advanced metal cutting technology. Results of Widia's pace setting R & D.

Tools — a very wide range — for almost every industry from machine tools to mining. Matched by Widia's consultancy service. Backed by an organisation ready to face the challenges of tomorrow. Through innovative excellence. Excellence in tools — recognised by advanced western countries, by accounting for bulk of Widia's exports from India. A breakthrough!

WIDIA

WIDIA IS A REGISTERED TRADEMARK OF KRUPP WIDIA ESSEN (GERMANY)

WIDIA (INDIA) LTD.

WIDIA-*leadership through technological breakthrough*

CAS-WIL-80100

How much do you know about BIRDS?

quiz



Which is the world's smallest bird? How did the word "cuckold" originate? Here are 20 such questions from ornithology Answers overleaf

1. All birds have A the same number of feathers B bills C the same number of toes D thick tongues

2. Which of the birds named has the longest migratory flight? A The swallow B The emu C The arctic tern D The caspian tern

3 Most species of which of the following group are brood parasites (lay their eggs in the nests of other birds)? A Ducks B Eagles C Storks D Cuckoos

4. Of these, which bird has only two toes? A The ostrich B The hornbill C The kingfisher D The quetzal

5. Polygyny (having more than one female mate) is practised by A crows B kites C the baya sparrow D sunbirds

6. Polyandry (having more than one male mate) is practised by A the brahminy kite B the pheasant-tailed jacana C pheasants D bush quails

7. The largest egg known is that of A the king vulture B the rhea C the ostrich D the elephant bird

8. Renowned as a mimic of human speech is A the grey parrot B the mocking bird C the lyre bird D the whistling thrush

9. Birds that regularly consume salt water with impunity are A the swans B the sandpipers C the albatrosses D the birds of paradise

10. Which of the following is known to use a non-vocal sound during its courtship? A The woodpecker B The kingfisher C The hornbill D The cuckoo

11. A bird which has an odd-shaped bill peculiar to its genus is A the parrot B the pelican C the ibisbill D the openbill stork

12. An expert flier that often spends nights soaring in the sky and sleeps while doing so is the A swift B penguin C albatross. D bird of paradise

13. One of the few 'tool using' birds is A the woodpecker B the weaver-bird C. the oven-bird D the Egyptian vulture.

14. Bee-eaters and kingfishers lay their eggs in A twig nests B on the bare ground C in nests tunnelled in the earth. D in purse-shaped pendulous nests

15. Birds are the only animals that A fly. B have beaks C have feathers D lay eggs

16. A bird that builds an outsize nest but never broods is A the emperor penguin B the osprey C the mallee fowl D the ringed plover

17. Sexual dimorphism is seen in A the crows B the wagtails C the egrets D. the ruff

18 The smallest living bird is A the pigmy woodpecker B the pigmy flowerpecker C the bee hummingbird D the pigmy tit

19 The heaviest flying bird is A the Californian condor B the emu C the wandering albatross D the mute swan

20 A bird that makes a nest of her own and hatches eggs in it but also lays some eggs in the nests of other females of her own species is A the ostrich B the partridge C the pelican D the flamingo



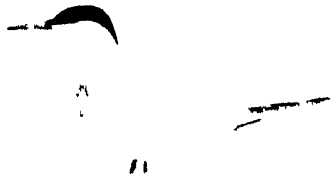
PRATIBHA-C-31/80



The Answers

1.—B: All birds have bills, though in size, shape, colour and functions there is an amazing diversity. The number of feathers in the plumage varies from species to species. Taking only contour feathers (those that give the bird its characteristic colours and are visible to us on the surface of the body) into account, the number varies from "940 on a humming bird to 25,216 on a whistling swan" (Rand, *Ornithology*). The number of toes varies from two to four. Most birds have thin tongues.

2.—C: The emu is a flightless ratite; many swallows and the Caspian tern are migratory, but their journeys are much shorter than the Arctic tern's. Generally regarded as the champion migrant, the Arctic tern breeds up to latitude 82°N in the Arctic and reaches latitude 74°S in the Antractic, about 17,600 km away. But as birds do not travel in a straight line, individual Arctic terns may cover 48,000 to 64,000 km every year



An Arctic tern

3.—D: No eagle or stork is known to be a brood parasite. The blackheaded duck of South America is the only parasitic species among ducks. Most species of the cuckoo family are nest parasites. The word "cuckold" derives from this fact. Other well-known parasitic birds are the cow-birds of America, the honey guides and the weaver-finches of Africa.

Cuckoo removing egg from tree pipit's nest



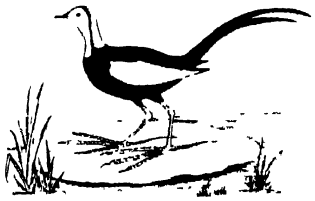
4.—A: The other three all have more than two toes. Their peculiarities are that (1) in the hornbills three of the four toes are united together; (2) in the kingfisher two toes (the fourth and the fifth) are united together; and (3) in the quetzal the first and second digits are directed backwards while the third and the fourth point forwards. This is an arrangement found only in the trogon family of which the quetzal is a member. One species of quetzal, the aptly named "resplendent quetzal", was worshipped by the ancient Mayans and Aztecs.



An ostrich's toes

5.—C: Kites and sunbirds are monogamous. Crows are not only monogamous, but they are believed to pair for life. The male baya weaver acquires a harem. He builds a number of nests in succession, attracts a female to each of these nests, and leaves the females to incubate the eggs and feed the young ones.

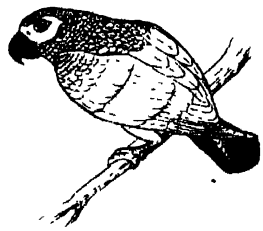
6.—B: The brahminy kite is monogamous; most pheasants and bush quails are polygamous. In the pheasant-tailed jacana, a bird of India and south-east Asia and the most beautiful member of its family, it is the female who establishes a territory. She courts the male, mates with him and lays a clutch of eggs. Thereafter she takes little interest in the eggs and the young ones. They become the sole responsibility of the male. The female goes in search of another mate and, after laying a second clutch of eggs for him to brood, shifts her attention to yet another mate. In polyandrous birds the female is more brightly coloured than the male, but this is not true of the pheasant-tailed jacana.



The pheasant-tailed jacana

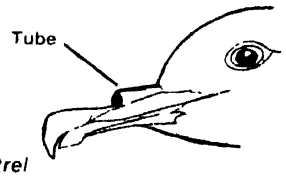
7.—D: So far as our knowledge goes, the extinct elephant bird of Madagascar laid the largest egg. It was 35.83 cm long. The parent was also the largest bird known to science. It weighed nearly 450 kg. The weight of a bird's egg is not, however, in direct proportion to the weight of its body. An egg of the ostrich weighs only 1.7 per cent of the bird's weight. The kiwi of New Zealand lays an egg weighing one-third the weight of its own body.

8.—A: The whistling thrush (a bird of the Indian hills) is not a mimic although it is known as the "whistling schoolboy" and its song is suggestive of the merry notes whistled by a carefree schoolboy. The mocking bird of America and the lyre bird of Australia weave the call-notes of other birds into their own elaborate songs, but they do not mimic human speech. The hill myna of India and south-east Asia and some members of the parrot family learn to talk when they are caged and tutored. Of such "talking birds", the African grey parrot, a large dumpy bird with a short red tail, is regarded as the most skilful.



The African grey parrot

9.—C: The albatross is an oceanic bird belonging to the order Tubinares (tube-nosed birds). They spend most of their lives far away from land which they visit only in order to nest. All pelagic birds naturally ingest large quantities of salt. But their kidneys not being efficient enough to excrete the excess salt quickly, these birds are equipped with special nasal glands of considerable size whose function is to eliminate the excess salt. These glands are connected to long tubes leading to their nostrils. The tubes are more conspicuous in petrels than in albatrosses. Hence the profile of a petrel's head is figured here. A highly concentrated salty fluid is said to flow constantly through these tubes



Head of petrel

10.—A: All woodpeckers are highly vocal and most of them use their loud call-notes to maintain their territories as well as to communicate with their mates and rivals. But many members of this large family also employ an instrumental sound, known as drumming. Choosing a dead branch or some part of the trunk where there is a natural cavity, the woodpecker delivers a series of vertical blows at the same spot. These blows are quite different from those employed in feeding and nest-building. They are incredibly rapid. The head of the bird works like a power-drill, and the resulting sound has been aptly described as a "rolling tattoo". Some woodpeckers are known to use a tin roof or a metal pipe for such drumming.

11.—D: All four have oddly shaped bills. The beaks of parrots bear a superficial resemblance to those of eagles and other birds of prey although most parrots are frugivorous (feeding on fruits and seeds). The long, downcurved beak of the ibisbill is very similar to those of the curlew and the whimbrel. Although only the pelican

Mohan Sivanand



has a bill "that can hold more than its belly can', other members of the family are also equipped with gular pouches (bags of thin membrane attached to the lower jaw) The genus *Anastoma* (the openbills) is unique in that the bills of all adult members show a distinct gap between the two mandibles as shown in the figure This anatomical peculiarity is believed to have evolved to enable these birds to feed on mussels



An open billed stork

12 — A The penguin cannot fly The albatross is an expert flier but is not known to sleep on the wing Birds of paradise are renowned for resplendent plumages and remarkable courtship displays not for their power of flight The common swift (closely related to our house swift) has been proved to spend the night on the wing and to sleep while soaring high over the sea

13.—D The woodpecker is a carpenter among birds chiselling out its nest with its own beak The baya sparrow is celebrated for its skill as a weaver but it uses its own bill and feet for weaving its wonderful nest The oven bird is a potter who builds a curious globular nest of mud with no tool other than its beak The Egyptian vulture (Pharaoh s chicken) is very fond of the contents of ostrich eggs but its bill is too weak to crack open the thick-shelled gigantic eggs of the ostrich It has however, learned the trick of picking up stones and flinging them at the eggs until the eggs break Till this habit of the Egyptian vulture came to light, the only real tool-user among birds was believed to be one of the Galapagos finches (Darwin's finches), which uses a cactus spine or a thin twig to probe into crevices and dislodge hidden insects



The tool-using Egyptian vulture

14.—C Kingfishers, bee-eaters and some other birds too (bank mynas, sand martins, motmots, etc) excavate long, narrow tunnels ending in round cavities in which they lay their eggs and raise their young Most of them choose a perpendicular sand- or mud-bank to tunnel into, but the common green bee-eater often digs into level ground, driving its tunnel downwards at an angle of 45°

15 —C Many creatures other than birds can fly quite well Numerous insects and at least one mammal move through the air by flapping their wings There are some birds that cannot fly at all Well-known examples are the ostrich and the penguin The duckbill platypus is a mammal that has a bird-like bill Insects fishes reptiles amphibians and a few mammals such as the platypus and the echidna lay eggs Only birds have feathers

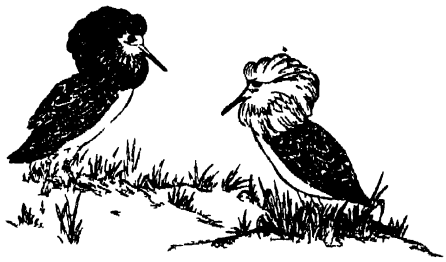
M S



A crowned peacock Feathers can take many beautiful forms

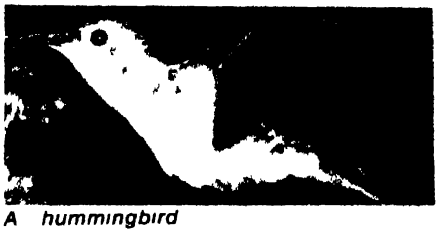
16 —C The emperor penguin does not build any kind of nest The male forgoing food and movement for two months, keeps the single egg on the webs of his feet and covers it with a fold of his abdominal skin The ringed plover sits in the sand and turns round a few times to make a shallow saucer-shaped nest The osprey builds a huge twig nest which it uses year after year until the nest becomes an enormous mound of faggots But the osprey incubates its eggs constantly The mallee fowl of Australia, a megapode buries its eggs in a carefully constructed heap of decaying vegetation and sand The bird does not incubate the eggs But the male regularly visits the nest, tests the temperature of the interior with his bill which is as sensitive as any thermometer, and makes such alterations to the mound as will keep the temperature more or less constant

17.—D In A, B and C the sexes are alike in outward appearance But sexual dimorphism is quite common among birds In most species the male and the female have different colours at least during the breeding season The ruff, a member of the sandpiper family, is unique in that breeding males not only develop an extraordinary collar of feathers (the 'ruff' was a striking feature of Elizabethan wear), but the collar of each male has a combination of colours and patterns that is as individual as the human fingerprint. Males assemble in large numbers at particular dancing grounds—known as hills—and indulge in spectacular displays



Male ruffs displaying

18 — C All four are among the smallest birds in the world, but most authorities name the bee humming bird of Cuba as the tiniest of living birds It is only 5 6 cm from bill tip to tail-tip It weighs only 1 gram 1/100 000 the weight of an ostrich A bee humming bird can just about cover the eye of an ostrich!

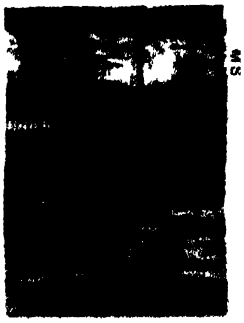


A hummingbird

19 —D The emu does not fly at all, the condor and the albatross are among the largest flying birds, but their combined weight may be less than the male mute swan s which may exceed 23 kg

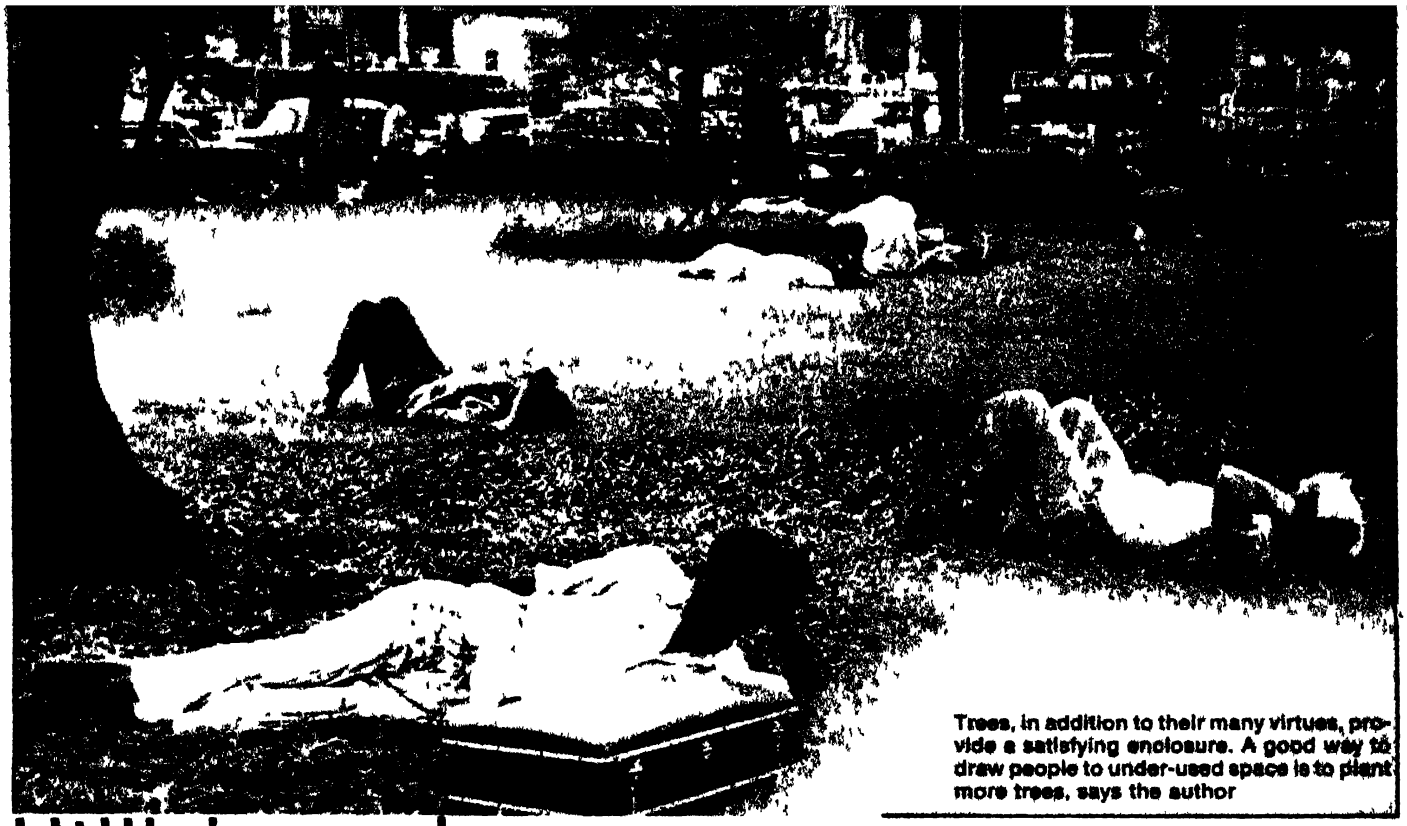
20.—A A recent discovery is that the nesting habits of the ostrich are quite extraordinary Female ostriches build nests of their own in which they lay 10 to 11 eggs They diligently incubate these eggs but when their husbands take over the job of brooding the females who can lay about 30 eggs in a season, drop their eggs (one at a time) in the nests of other females This extraordinary practice of foisting some of their eggs on each other gives every pair of ostriches a better chance of preserving their own genes

M S



An ostrich

This quiz including the line drawings was prepared by PROF K K NEELAKANTAN who is President Kerala Natural History Society Trivandrum and an ardent ornithologist bird artist and author of several books and articles on birds both in English and Malayalam



Trees, in addition to their many virtues, provide a satisfying enclosure. A good way to draw people to under-used space is to plant more trees, says the author

Utilising urban spaces

William H. Whyte

The livability of future cities may depend on a more imaginative use of open spaces What are the basic elements that make urban spaces more appealing?

TEN YEARS ago I formed a small group of observers and began looking at city streets and spaces in New York and how people used them I did it because I thought it would be interesting, but as with all such enterprises, I had a proper research design and many fine hypotheses Most were about overcrowding, which was then very much on peoples' minds Experiments with mice were demonstrating that very high population densities induced neurotic behaviour By inference, so did cities What about people? How did they respond? How many were too many? In what circumstances? With the help of some foundation grants we set forth on our research—and a succession of broken hypotheses

We started by looking at playgrounds and such informal recreation areas as city blocks What soon struck us was the lack of crowding in many of these areas A few were jammed, but more were nearer empty than full, often in neighborhoods that ranked very high in density of people Sheer space, obviously, did not of itself attract children. But many streets did One of the best play areas we came across was a block on 101st Street in East Harlem It had its problems, but it worked The street itself was the play area Adjoining stoops and fire escapes provided prime viewing across the street and were highly functional for mothers and older people. There were other factors at work, too, and had we been more prescient, we could have saved ourselves a lot of time spent later looking at plazas Although we did not know it then, this block had all the basic elements of a successful urban space

As our studies took us nearer the centre of the city, the imbalance in space use was even more apparent. Most of the crowding could be traced to a series of choke points—subway stations, in particular Elsewhere, however, there was a surprising amount of underused space. Office building plazas were prime examples. Since 1961, New York City has been giving incentive bonuses to builders who provide public plazas; for each square foot of plaza, builders can add ten square feet of commercial floor space over and above the amount normally permitted by zoning So they did—without exception

We found that some plazas did attract people The plaza of the Seagram building was one On a good day, there would be 150 people sitting, sunbathing, picnicking, and "shmoozing"—idly gossiping, talking "nothing talk" But on most plazas, there weren't many people. In the middle of the lunch hour on a beautiful, sunny day, the number of people sitting on plazas averaged four per 1,000 square feet of space, an extraordinarily low figure for so dense a centre. The city was being had. For the millions of dollars of extra space it was handing out to builders, it had every right to demand much better plazas in return.

I put the matter to the people at the City Planning Commission. They agreed that tougher zoning was in order. If we could find out why the good plazas worked and the bad ones didn't and come up with hard guidelines, we would have the basis of a new code.

We set to work. We began studying a cross section of plazas, small parks,

and street corners, and observing how people used such spaces. We mounted time-lapse cameras and recorded daily patterns. We talked to people too, but mostly, we watched them to see what they did. What attracts people, it became apparent, is other people. Many spaces are being designed as though the opposite were true, and that what people like best are the places other people stay away from. People often talk along such lines. They speak of getting away from it all, and use terms like "escape," "oasis," "retreat." What people do, however, reveals a different priority.

This was brought home to us in a study of street conversations. We wondered how far away people move from the main pedestrian flow when they stop to have a conversation. We were especially interested in finding out how much of the normally unused buffer space next to buildings was used. So we set up time-lapse cameras overlooking several key street corners and plotted the location of all conversations lasting a minute or longer. But the people didn't move out of the flow. They stayed in it or moved into it, and the great bulk of the conversations were held smack in the centre of the flow—the "100 per cent location," to use real-estate terminology. The same gravitation characterised "travelling conversations," those in which two men move about, alternating the roles of straight man and principal talker. There is a lot of apparent motion, but if you plot the orbits, you will find they usually revolve around the 100 per cent spot. To a large degree, congestion is self-congestion. Just why, we have never been able to determine. That conversations should originate within the main flow is understandable. Where there are the most people, the likelihood of a meeting or a leave-taking is highest. What is less explainable is people's inclination to remain in the main flow, blocking traffic, being jostled by it. This does not seem to be a matter of inertia, but of choice—instinctive, perhaps, but by no means illogical. In the centre of the crowd you have the maximum choice—to break off, to continue—much as you have in the centre of cocktail party, itself a moving conversation growing ever denser.

People like to sit in the mainstream. At the Seagram plaza, the main pedestrian paths are on diagonals from the building entrance to the corners of the steps. These are natural junction and transfer points, and there is usually a lot of activity at them. They are also a favoured place for sitting and picnicking. Sometimes there will be so many people that pedestrians have to step carefully to negotiate the steps. The pedestrians rarely complain. While some will detour around the blockage, most will thread their way through it.

Standing patterns are similar. When people stop to talk on a plaza, they usually do so in the middle of the traffic stream. They also show an inclination to station themselves near objects, such as a flagpole or a pillar. They like well-defined places such as steps or the border of a pool. What they rarely choose is the middle of a large space. The preference for pillars might be ascribed to some primeval instinct: you have a full view of all comers but your rear is covered. But this doesn't explain the inclination men have for lining up at the curb. Typically, they face inward, toward the sidewalk, with their backs exposed to the dangers of the street.

Foot movements are consistent, too. They seem to be a sort of silent language. Often, in a group no one will be saying anything. Men stand bound in amiable silence, surveying the passing scene, then, slowly, rhythmically, one of the men rocks up and down: first on the ball of the foot, then back on the heel. He stops. Another man then starts the same movement. Sometimes there are reciprocal gestures. One man makes a half-turn to the right; after a rhythmic interval, another responds with a half-turn to the left. Some kind of com-



Mohan Sivanand



Dev Gogoi

Sheer space does not by itself attract children. Very often, spaces in towns and cities intended for recreation are seen empty. But the street itself is often the favourite play area. *Above:* People sit wherever there are places to sit, and like the idea of lining up beside the road, their backs exposed to the dangers of the road





Big-city people walk faster and tend to self congest more Travelling conversations are held smack in the centre of the flow Behaviour patterns among city folk are much the same in the world s largest cities *Top left* Much of the crowding in big cities can be traced to a series of choke points railway stations in particular

munication seems to be taking place here, but I have never broken the code

Whatever they may mean, people's movements are one of the great spectacles of a plaza You do not see this in architectural photographs, which typically are empty of life and taken from a perspective, often a misleading one, that few people share At eye level you see movement and colour—people walking quickly, walking slowly, skipping up steps, weaving in and out on crossing patterns, accelerating and retarding to match the moves of others There is a beauty that is beguiling to watch, and the players themselves seem aware of it With its brown-gray monochrome, the Seagram plaza is the best setting for them—especially in the rain, when an umbrella or two spots colour in the right places, like Corot's red dots

From city to city, behaviour patterns are much the same The strongest similarities are found among the world's largest cities People in them tend to behave more like their counterparts in other world cities than their fellow countrymen in smaller cities For one thing, big-city people walk faster and tend to self-congest more In a brief comparison study we made in Tokyo, we found that the proclivity to talk in the middle of doorways and busy corners was just as strong as in New York Similarly, in Milan's Galleria the conversational groupings were remarkably like the patterns on Seventh Avenue

Next we turned to the physical characteristics of plazas and how they might explain why lots of people sat on some plazas, but only a few on others I had hypothesised that sun patterns were the critical factor For a while, our time-lapse studies bore this out where the sun was, the people were, where it wasn't, they weren t Then the correlation vanished As June followed May and the weather got warmer, people sat almost anywhere, sun or shade Sun was important to have, certainly, but it did not explain the differences in popularity of plazas

Nor did the shape of plazas Some urban designers were sure that the proportions of the spaces were critical, and they were especially interested in ruling out long, narrow spaces But our findings afforded no documentation Some long, narrow spaces looked terrible and were empty most of the time, but so were some square spaces Two of the most successful places in the city were long, narrow spaces

Could the *amount* of space be the key factor? A number of conservationists thought so, in their view, people seek open spaces as a relief from the overcrowding they normally experience If we were to rank plazas by the amount of open space provided, there would likely be a rough correlation between the size of the plazas and the number of people using them There was not, if anything, there was a reverse correlation

We turned to the amount of sittable space Here we got closer We went on to check many other factors enclosures, pedestrian flows, nearness to transit, and such But as we piled up all the data, overlay by overlay, one major finding emerged· People tend to sit most where there are places to sit

This may not be an intellectual bombshell, but at the time it was not at all obvious to a number of architects and planners They



Benches can often be left unoccupied if they are badly placed or designed The evening crowds at Marine Drive Bombay leave the benches alone and prefer the curb probably because the benches face the sun and not the street

believed aesthetics of design were what drew people to come and sit. Some still do.

The key variable, however, is sitting space, and the places that have it tend to be good in other respects as well. Sittable space means choice. It is all the better, of course, if the space is physically comfortable: benches with backrests, for example, or well-contoured chairs. But more important is that it be socially comfortable. That is why ledges are so functional. They give people lots of room to sort themselves out; all the more so if the ledges are two backsides deep.

Steps are also great for sitting. They give a fine view of the theatre of the street and provide an almost infinite combination of groupings. Corners of steps are especially popular. The right angles are very good for groups and at lunchtime are quickly preempted for picnics. This should create conflict. Since people generally take the shortest cut, the corners of steps are also precisely where the pedestrian traffic is usually heaviest. Still it all seems to work out. For all the coming and going, the sitters seem quite comfortable. The walkers don't seem to mind either and will carefully negotiate their way through the sitters rather than detour to the open areas. Sometimes the whole length of the steps is blocked by sitters. This is a good sign, the hallmark of an unusually successful place.

Although benches can work well, too often they do not. They are usually too small; there are too few of them; and they are spotted in isolation, one from the other, like design objects. Benches should be generously proportioned and flexibly arranged. Fixed individual seats are not good. The trouble with them is that they are set pieces. Social distance is a subtle measure, ever changing, and since the distances of fixed seats do not change, they are rarely right for anybody.



MS



Left. A pillar or post offers some sort of protection from behind. *Above* The movable chair provides more than just comfort—it enables one to vary social distances.

Best of all is the movable chair. It is a splendid invention and for more reasons than comfort. Its movability is the secret. A chair provides the maximum amount of choice—in the sun, out of it, up front, to the back—and the possibility of choice is more important than the exercise of it. Watch people as they approach a chair. They will probably move it; there seems to be a deep impulse in us to do so. The move may be only a matter of a few inches and in many cases is followed by a series of countermoves, with the chair ending up where it was in the first place. But the moves have point; they are an assertion of one's free will and satisfying to make.

Moves can also be a nice social ritual. When taking a chair next to some stranger, a person's moves say something to them. The message may be: "Sorry about the closeness, but I'm going to respect your privacy as you will mine." A slight reciprocal move by one of the others may follow. Watching these exercises in civility is one of the pleasures of a good place.

Like a place to sit, the other major elements of a good urban space are basic, and while it might seem a contradiction in terms, they are *natural* elements. Sun, light, trees, water—nowhere is nature more important than in cities, where it is so marginal.

Sun is the prime example. True, a space can work without it: Paley Park in midtown Manhattan lost much of its sun to a building across the way; yet it remains very popular. But something of great value has been lost. Watch how people make the most of what sun there is and you realise how primeval is our reaction to it.

We are losing sun to new construction at an alarming rate. The problem is not only the bulk of the buildings but also a design approach that virtually ignores the sun. Few buildings acknowledge their neighbours, nor are they required to. Incentive zoning has many bonuses for making buildings bigger, none for having them provide more sun. They could. The same buildings that block sun can also reflect it. On streets with



MS

Street performers are great crowd-pullers—crowds form quickly around them. People always like them



"Undesirables" tend to stay away from crowds as in areas of parks where the public are kept out So planners can keep ' undesirables ' and winos away if places are made attractive enough to draw social crowds

buildings of limestone or other light-colored materials, the light bounced from them may make the shady side of the street measurably brighter. Such effects are inadvertent. Architects do sun studies for new buildings, more for defensive than other reasons, and tend not to fret over the consequences of shadows on other buildings. Neither do they consider the sun's positive benefits. With certain small changes, such as canting reflective panels on part of a tower, the architect could bounce some much needed light into dark places—Paley Park, for example.

Water is an element that designers are using rather well. Some plazas and parks now provide waterfalls, waterwalls, sluiceways, water tunnels, meandering brooks, tranquil pools, or fountains. The sound of water may be its best feature; a waterwall is loud—about 75 decibels—but it is a "white" sound that masks street noises and other people's conversations.

Another good thing about water is the look and feel of it. I have always thought the water at the Seagram plaza is unusually liquid, and I think it's because you know you can splash your hands or stick your toes in it if you are of a mind to. Not so in some places. A guard will come up. Forbidden! Pools of water are set before people and then posted with signs telling them not to touch the water. In Chicago's Grant Park, the grand old Buckingham Fountain has been put off limits with an electrified fence around it.

Safety is the reason usually given for such measures, but there are better ways than electrocution to handle this problem. At the Auditorium Forecourt Fountain in Portland, Oregon, people have been clambering up and down its sluiceways and falls for some seven years. While it looks dangerous—designer Lawrence Halprin designed it to look that way—there have been no serious mishaps since the day it opened. This splendid fountain is an affirmation of trust in people and it says much about the good city of Portland.

Trees are so obvious an amenity, the wonder is we haven't planted far more of them. In addition to their many other virtues, trees make the best of a sitting space. They provide a satisfying enclosure: sitting under one you can see all of the passing scene, while feeling somewhat protected, cuddled—much as you do under the awning of a sidewalk cafe. Builders should be required to plant many more trees and, where possible to plant them in groves. The overlapping foliage makes a fine canopy. Arbours can do the same.

Another basic is food. People will eat an astonishing amount of it outdoors, and if you want to seed a place with activity, food facilities will do it. Even a pushcart can be a strong draw. In New York you will see a pushcart vendor and a knot of people around him at almost every plaza or set of steps with a lively social life. Sometimes the police arrive with trucks and haul the carts away, a piece of street theatre invariably greeted with boos from the bystanders. Some cities are much more puritanical; they forbid not only the purveying but also the eating of food outdoors.

They are robbing themselves of a dynamic. Food has a strong shill





Food attracts people like nothing else Urban folk eat an astonishing amount outdoors. *Left:* Splashable water adds appeal to any public place



Everywhere there is the tendency to sit on steps and watch the street go by Steps provide the perfect view just as in an arena

effect Out of proportion to their numbers, people who eat ice cream cones, hot dogs, and lunch out of brown bags attract other people There has been a notable increase in the use of plazas where tables chairs, and snack bars have been set up From the street it sometimes looks as if a big party is going on and the sight induces passersby to venture in

Now we come to the key space for a plaza It is not the plaza, it is the street A good plaza starts at the street corner A busy corner has a brisk social life of its own, and there will be considerable two way traffic between plaza and corner Another key feature of a street is retailing—stores windows with displays and signs to attract your attention, doorways and people going in and out of them Big new office buildings have been eliminating stores, replacing them with a frontage of plate glass through which you can behold bank officers sitting at desks One such stretch is dull enough, block after block of them creates overpowering tedium

The area where the street and the plaza, or open space, meet is a key to success or failure Ideally the transition should be such that it is hard to tell where one ends and the other begins New York s Paley Park is the best of examples The sidewalk in front is an integral part of the park Arbourlike foliage extends over the sidewalk There are urns of flowers at the curb and curved sitting ledges on either side of the steps In this foyer you can usually find somebody waiting for someone else—it is a convenient rendezvous point—people sitting on the ledges, and in the middle of the entrance, several people in conversation Even passers-by who don't go into Paley benefit About half will smile I haven't calculated a smile index, but this vicarious enjoyment is extremely important—the sight of the park, the knowledge that it is there becomes part of the image we have of a much wider area If one had to make a cost-benefit study, I think it would show that secondary use provides as much, if not more benefit than the primary use

If such places are so felicitous why are there not more of them? The reason is the undesirables They are not themselves, much of a problem The problem is the measures taken to combat them Many businessmen have an almost obsessive fear that if a place is attractive, it might attract undesirable people So the area is made unattractive There is to be no loitering, no eating no sitting Benches are made too short to sleep on and spikes are put in ledges, most important many needed spaces are not provided at all or the plans for them scuttled

Ironically places designed with distrust get what they were ostensibly avoiding and it is in such places that you will most likely find a wino You will find winos elsewhere, as well, but they prefer the empty places The best way to handle the problem of undesirables is to create an area attractive to everyone else The record is overwhelmingly positive on this score With few exceptions, plazas and small parks in most central business districts are probably as safe a place as you can find during the times that people use them

There is one more factor to consider I call it triangulation By this I mean that process by which some external stimulus provides a linkage between people and prompts strangers to talk to each other There, say, two men standing at a street corner A third man appears, hoists a sign, and begins a loud harangue on the single tax This links the first two men Casually, they exchange comments on the scene before them, in a tone of voice usually reserved for close friends

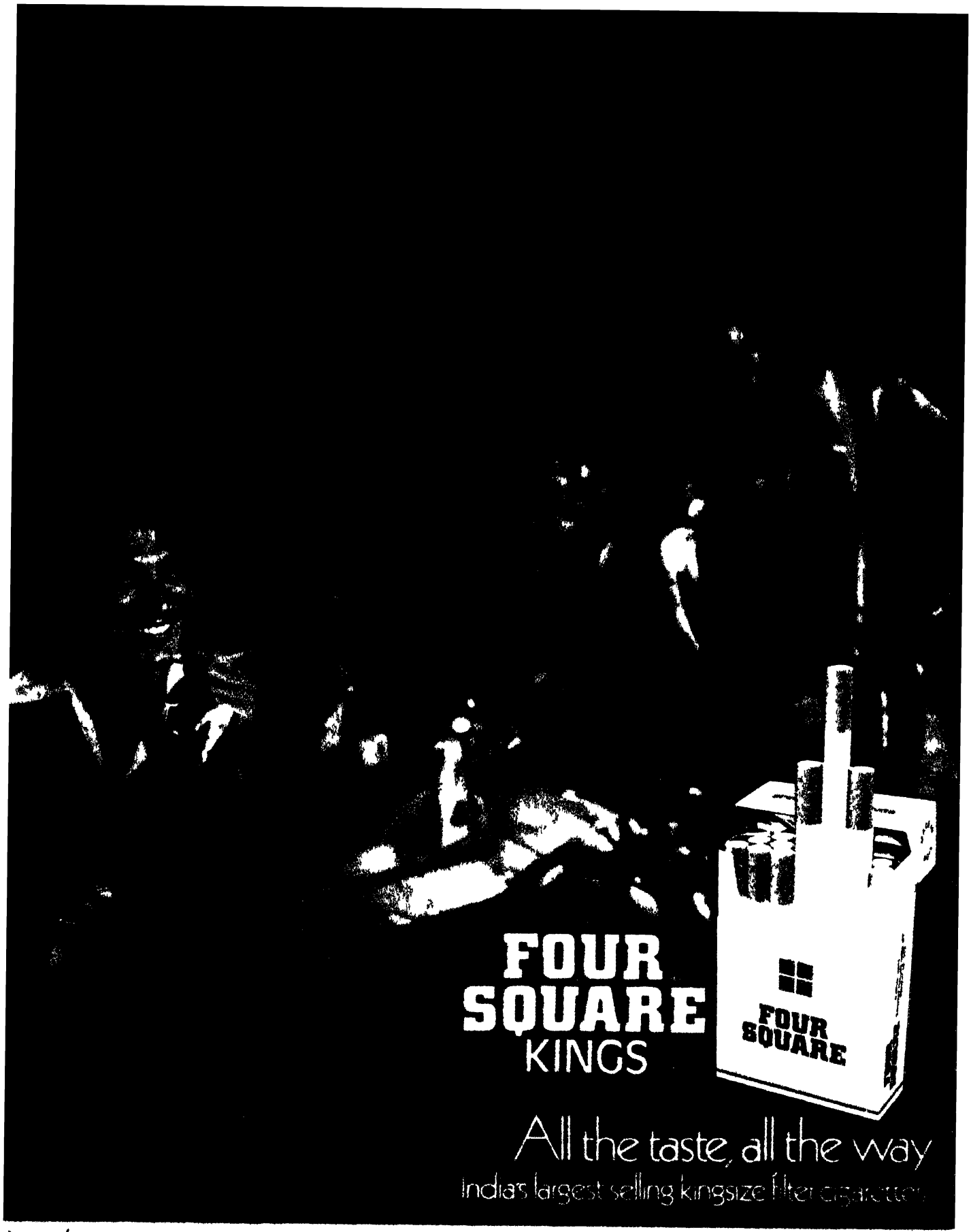
Musicians and entertainers also draw people together Rockefeller Plaza and the First National Bank of Chicago regularly schedule touring school bands, rock groups, and the like The real show, however, is usually the audience Many people will be looking as much at each other as at what is on the stage

Street performances are great crowd gathers and they have the virtue of unexpectedness When people form a crowd around an entertainer—it happens very quickly, in 40 or 50 seconds—they look much like children who have come upon a treat some will be smiling in simple delight These moments are true recreation although rarely thought of as such, certainly not by the shopkeepers who try so hard to outlaw them But people like them, and they are right

I am not heaven forfend, arguing for places of maximum gregariousness or social directors of plazas Anomie would be preferable What I m suggesting, simply is that we make places friendlier

I am, in sum, advocating busy places Too busy? Too crowded? I think not People have a nice sense of the number that is right for a place, and it is they who determine how many is too many Furthermore, they do not seek to get away from it all They go to the lively places where there are many people And they go there by choice, not to escape the city, but to partake of it

William H Whyte is Director of the Street Life Project in New York City This article contains adapted material from his book The Social Life of Small Urban Spaces published by the Conservation Foundation 1980



GODFREY PHILLIPS INDIA LIMITED

STATUTORY WARNING : CIGARETTE SMOKING IS INJURIOUS TO HEALTH

Menon is new INSA president

PROF M G K Menon, Secretary to the Government of India Department of Science and Technology and Director General, Council of Scientific and Industrial Research, has been elected President of the Indian National Science Academy. Prof Menon will assume office after the Academy's annual general meeting on 2 January 1981 when Dr V Ramalingaswamy will relinquish charge.

The other officers selected for 1981 are: *Vice presidents* Prof S C Bhattacharyya (Calcutta) and Dr A S Paintal (Delhi) *Treasurer* Dr V G Bhide (Delhi) *Foreign Secretary* Prof D H Pai (Ahmedabad) *Secretaries* Dr A P Mitra (Delhi) and Prof P N Tandon (Delhi) *Editors of publications* Prof A Y Mohan Ram (Delhi) and Prof S K Trehan (Chandigarh).

The members of the INSA Council are: Prof I R Ananthanarayan (Varanasi) Prof P K Bhattacharyya (Bangalore) Prof R R Daniel (Bombay) Dr S Dhawan (Bangalore) Dr H K Jain (Delhi) Prof G K Manna (Kalyani) Prof R C Mehrotra (Jaipur) Prof R C Misra (Varanasi) Prof H H Nigam (Allahabad) Prof S Raghavan (Bombay) Prof M R Rajasekharan Shetty (Mysore) Prof O Siddiqi (Bombay) Dr Supriya Roy (Calcutta) Prof Archana Sharma (Calcutta) Prof M M Sharma (Bombay) Dr Yash Pal (Ahmedabad) and Prof V Ramalingaswamy (Delhi past President ex officio).

Aryabhata Medal

DR B P PAL Chairman National Committee on Environmental Planning and Coordination has been awarded the 1980 Aryabhata Medal in recognition of his outstanding work in environmental planning. The Aryabhata Medal was instituted by the INSA in 1977 and is one of the three general medals awarded by the Academy each year.

Vishwakarma Medal

THE INSA's first Vishwakarma Medal for 1979 awarded every three years to scientists technologists or any one whose discovery or invention has led to the start of a new industry in India or to significant improvement of an existing process resulting in cheaper or better product', goes to Dr Sukh Dev, director of a chemical research centre at Nandesari, Baroda.

Dr Sukh Dev is well known for his work on the chemistry of natural products, particularly terpenoids. He has earlier won the Bhatnagar Prize for Chemistry, and is the only Indian to have received the Fritzsche Award of the American Chemical Society. The Vishwakarma Medal carries with it a cash award of Rs 7 500 and a citation.

INSA Silver Jubilee Medal

THE INSA has awarded its Silver Jubilee Commemoration Medal for 1979 to Dr Mohinder Singh Randhawa. Dr Randhawa has distinguished himself as a botanist agriculturist literateur, art critic historian and administrator says the citation accompanying the medal.

Independence Day (1980) awards for meritorious inventions

THE NATIONAL Research Development Corporation of India has announced Independence Day (1980) awards for meritorious inventions. Awards totalling Rs 16 000 and a certificate of merit have been given for the following seven inventions.

Dr S C Sethi of National Chemical Laboratory, Pune has been awarded a sum of Rs 5 000 for the development of a process for the manufacture of para methane hydroperoxide which is required in the polymerisation of synthetic rubber. With this process a larger yield is obtained.

Mr P Pillaiyar of the Paddy Processing Research Centre, Tiruvarur and Mr Mohammed Kutharathulla of the Solvent Extraction Plant, Food Corporation of India, Sembanarkoil, Tamil Nadu have been jointly awarded Rs 4 000 for the invention of a method for pelletising parboiled rice bran without additive. This method of pelletisation reduces the cost of extracting parboiled rice bran.

Mr H S Kalkat and Dr S R Verma of Punjab Agricultural University, Ludhiana have been jointly awarded Rs 2 000 for the design and development of a power operated groundnut thresher.

Mr R G Regoubady and Mr R Venkatesan of that Welding Research Institute, BHEL, Tiruchirapalli, have been jointly awarded Rs 2 000 for development of an attachment for a welding generator or a welding transformer.

Dr G Venkataraman of BHEL, Tiruchirapalli, has been awarded a sum of Rs 2,000 for his invention, residual stress measuring x-ray diffraction camera with film oscillations.

Mr Sadasivan Nair Shankarapillai and Mohan Lal Jain of SKN College of Agriculture, Jobner (Rajastan), have been jointly awarded a sum of Rs 1,000 for the development of a simple machine for mechanical picking of Indian gooseberry'.

Mr Poonamallee Murugaiyan, Mr Srinivasan Natarajan and Mr. Caetano Concesco Dias of the Bhabha Atomic Research Centre, Bombay, have been awarded certificates of merit for the development of Mercury Analyser-Optical System and Pump.

Coal scientist award to CFRI scientist

MR B K MAZUMDAR deputy director, Central Fuel Research Institute, Dhanbad, has been named for the newly instituted Senior Coal Scientist Award for 1979 by the Ministry of Energy and Coal, Government of India.

Mr Mazumdar has been doing outstanding work in the field of coal constitution, systematics and basic research on many allied areas of coal utilisation. The award carries a cash prize of Rs. 5 000. The Junior Coal Scientist award for 1979 was not made.

VASVIK awards

PROF M G K Menon Secretary to the Government of India Department of Science and Technology and Chairman, Board of Advisers Vividhlaxi Audvogik Samshodhan Vikas Kendra (VASVIK), announced the names of the following winners of the 1979 Vasvik research awards.

Agricultural Sciences Dr N Ganga Prasad Rao Head National Research Centre for Sorghum Hyderabad.

Biological Sciences Mr P S Appukuttan, Dr Subal Bishayee, Dr Avadhesha Surolia and Dr D Thambi Dorai, all of Indian Institute of Experimental Medicine, Calcutta and Dr Shiv Pillai of the Kothari Centre of Gastroenterology, Calcutta.

Chemical Sciences Dr K S G Doss of Madras and Dr Sukh Dev of Nandesari, Baroda.

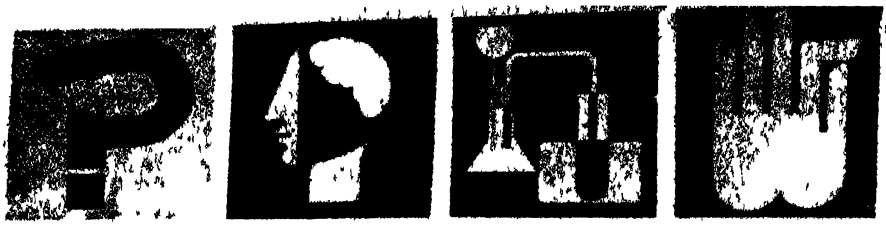
Electronic Sciences Mr T V Ramamurti and Mr N Radhakrishna Nair both of Sahibabad.

Material Sciences Mr C V Sundaram, Head Metallurgy Division Bhabha Atomic Research Centre Bombay.

Mechanical Sciences Prof G N V Rao, Prof T N Krishnaswamy Prof S Durvasulu and Shri K Ramamurthy Reddy all of Indian Institute of Science Bangalore.

No Award was given for Electrical Sciences this year. Prof Menon also announced the names of the recipients of the two 1978 awards the announcement for which had been delayed. These are—*Material Sciences* Prof S Ramaseshan Joint Director Indian Institute of Science Bangalore. *Mechanical Sciences* Dr S R Valluri Director National Aeronautical Laboratory, Bangalore.

The award in each of the seven disciplines consists of Rs 25,000 a gold medal and citation to each winner.



The method of science

11

Text©P M. Bhargava

Design Feroze Chandra

Science is truly international

Scientists all over the world:

— Use the same method: the method of science;

— Employ the same techniques;

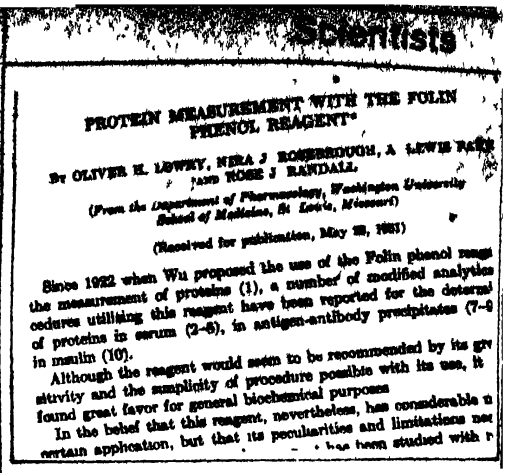
— Are increasingly beginning to use the same language;

— Publish frequently in the same journals;

— Use the same materials;

— Form a truly international community in which the professional links are at least as strong as any other link.

Scientists



PROTEIN MEASUREMENT WITH THE FOLIN PHENOL REAGENT*

By OLIVER H. LOWRY, NIRA J. ROSEBROUGH, A. LEWIS FARR, AND ROSE J. RANDALL.

(From the Department of Pharmacology, Washington University School of Medicine, St. Louis, Missouri)

(Received for publication, May 28, 1951)

Since 1922 when Wu proposed the use of the Folin phenol reagent for the measurement of proteins (1), a number of modified analytical procedures utilizing this reagent have been reported for the determination of proteins in serum (2-6), in antigen-antibody precipitates (7-9), and in insulin (10).

Although the reagent would seem to be recommended by its great sensitivity and the simplicity of procedure possible with its use, it has not found great favor for general biochemical purposes.

In the belief that this reagent, nevertheless, has considerable merit for certain application, but that its peculiarities and limitations need ... has been studied with ...

1. LOWRY'S METHOD OF ESTIMATION OF PROTEIN

The method of estimation of protein described in the above paper by Lowry *et al* first published in 1951 has been—and continues to be—used by scientists all over the world. In one year (1972) alone, at least 5,925 scientists from a large number of countries around the world employed this method.

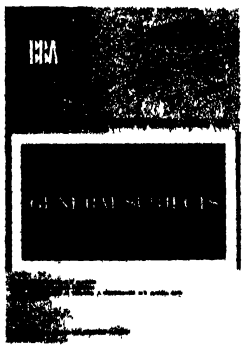
This paper is, as of today, the most frequently cited paper of all scientific research papers published so far in all branches of science and technology.

Scientists from all over the world often publish in the same journals

Whenever scientists make a new observation or hypothesis, or discover a new scientific fact, theory or law, they announce it by publishing the details of their work in a scientific journal read by other scientists in various parts of the world. Scientists elsewhere often repeat the published work, and either confirm or contradict it. They often publish their results as well—specially if they are contradictory to, or supplement the original finding—for scrutiny by other scientists, including the ones who did the work originally.

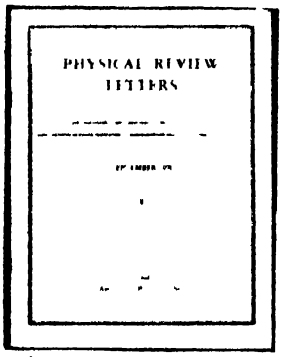
Publication of new and original findings in scientific journals is one of the important ways in which scientists from various parts of the world communicate with each other. Some scientific journals publishing new and original findings are read by more than a million people distributed all over the world.

In the three widely-read science journals displayed at right, papers from the following countries were published in the years 1973/1974.



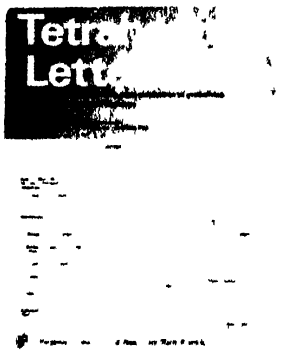
Biochimica et Biophysica Acta (in 1974)

Australia	Japan
Austria	Kenya
Belgium	Malaysia
Bulgaria	New Zealand
Denmark	Norway
Finland	Poland
France	Romania
Germany	South Africa
Greece	Spain
Holland	Sweden
Hong Kong	Switzerland
Hungary	UK
India	USA
Iceland	USSR
Israel	Yugoslavia
Italy	



Physical Review Letters (in 1973)

Australia	Sweden
Austria	Switzerland
Belgium	UK
Denmark	USA
France	USSR
Germany	
Greece	
Holland	
Hungary	
India	
Israel	
Italy	
Japan	
Malaysia	
Norway	
Poland	



Tetrahedron Letters (in 1974)

Australia	Italy
Belgium	Japan
Bulgaria	Mozambique
Czecho-slovakia	Poland
	Romania
Egypt	New Zealand
Finland	Norway
Formosa	South Africa
France	Spain
Germany	Sweden
Greece	Switzerland
Holland	Thailand
Hungary	UK
India	USA
Ireland	USSR
Israel	Yugoslavia

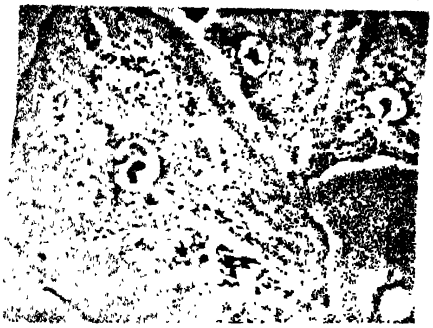
all over the world use the same techniques and material

2 (a) ALBINO MICE

These animals belong to a "genetically pure strain", that is, a breed in which every animal is genetically identical (like identical twins) to every other animal; these animals will, therefore, accept skin grafts from one another. Such an acceptance is a test of genetic identity; amongst human beings, only identical twins will accept skin grafts from each other.

You will find this strain of mice in use in laboratories all over the world.





Three Hela cells. The two cells in the top right-hand corner have just been 'born' by the division of a larger, parent cell

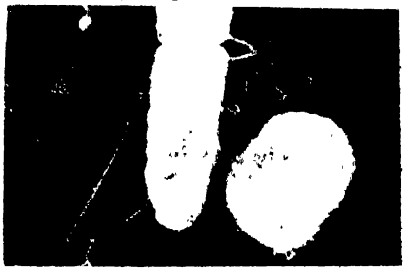
2 (b) HELA CELLS

In 1951, scientists took out some cells from a cancerous tumour in a woman called Henrietta Lacks. The cells were then grown in the laboratory. Soon afterwards she died of cancer, but her cells continued to multiply in the laboratory—first in one laboratory, then in a few more laboratories, and so on. Today, these cells have found their way into research laboratories all over the world. Henrietta Lacks, in a way, continues to live, and not just at one place!

2 (c) A BACTERIUM CALLED *ESCHERICHIA COLI*

The bacterium, *Escherichia coli* shown in the micrographs below is widely used in research laboratories all over the world.

These stereoscopic electron micrographs show two cells of Escherichia coli, *one male (bottom) and the other female (top), conjugating with each other.*



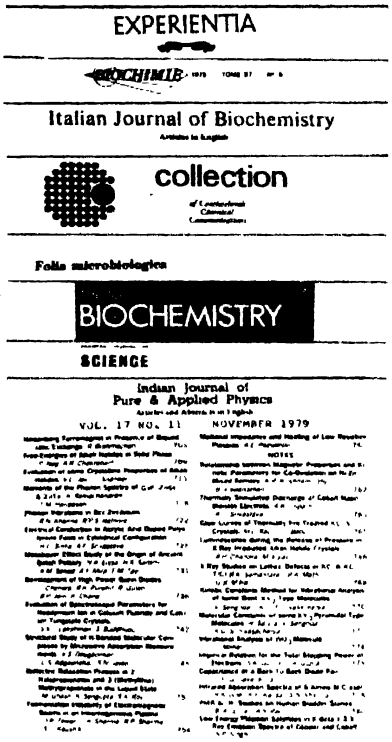


Scientists communicate with each other in the same language

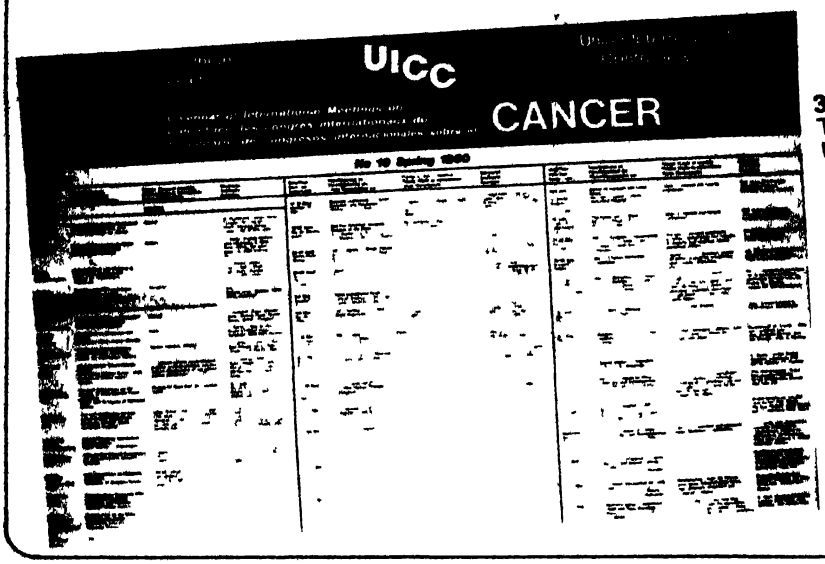
Scientists everywhere use, very largely, just one language—that is, English—when communicating with their counterparts in other parts of the world.

Most of the non-English speaking countries, where scientific research is done, bring out scientific journals which publish papers in English.

Country	Principal language(s)	Journal
Sweden	Swedish	Acta Chemica Scandinavica
Holland	Dutch	Biochimica et Biophysica Acta
Switzerland	French/German/ Italian/Romansh	Experientia
France	French	Biochimie
Germany	German	Hoppe-Seyler's Zeitschrift für Physiologische Chemie
Italy	Italian	Italian Journal of Biochemistry
Czechoslovakia	Czech	Collection of Czechoslovak Chemical Communications
Hungary	Hungarian	Folia Microbiologica
Poland	Polish	Acta Biochemica Polonica
Nigeria	Hausa (and many others)	Nigerian Journal of Science
Israel	Hebrew	Israel Journal of Technology
India	Hindi (and many others)	Indian Journal of Pure & Applied Physics
Pakistan	Urdu	Pakistan Journal of Scientific Research
China	Chinese	Scientia Sinica
Japan	Japanese	The Journal of Biochemistry
Brazil	Spanish	Anais da Academia Brasileria de Ciencias
Venezuela	Portuguese	Acta Cientifica Venezolana



Scientists meet at international conferences to discuss their latest findings



3-5 Jan. Tucson, AZ USA — Human Tumor Cloning Conference, Cancer Center Division, Univ. of Arizona, Health Sc. Center

16-21 Feb. Kuwait Kuwait — Clinical Cancer Chemotherapy Course

5-7 Nov. Tokyo Japan — 39th Annual Meeting of the Japanese Cancer Association



What do dogmatic belief systems have in common?

Contrast the characteristics of science we have just described—which make science a truly international activity—with the following characteristics of dogmatic beliefs we talked about in the earlier parts of this series:

— There are many systems of dogmatic beliefs, and they differ from one another in many respects,

— Activities under a system of dogmatic beliefs are carried out in isolation from the other systems of such beliefs People holding the other beliefs are often prohibited from participation

— There is little communication between different sets of dogmatic beliefs and, therefore, no common "language

— Practices sanctioned by dogmatic beliefs differ enormously—often fundamentally—from one system of beliefs to another, and show little, if any, overlap between different systems,

—Dogmatic beliefs divide people, unlike science which unites them

★★★

Amazing reports of relief from gum trouble

Two of the many letters Forhan's users write of their own accord.

"Not only cleans teeth, but also has capacity to do away with dental troubles"

"...Whenever I myself or any other member of our family suffers from pain in teeth and gums, we apply Forhan's Toothpaste...the pain subsides in no time. Your Forhan's toothpaste not only cleans teeth but also has capacity to do away with dental troubles..."

(Sd/- Deepa Sharad Patwardhan, Bombay)

(Photostats of these and other such letters can be seen at any office of Geoffrey Manners & Co. Ltd.)

"...Helping to possess a sound gum..."

"I have no hesitation to use the superlatives about the quality of Forhan's, an ideal Paste for all, mainly for those who are suffering in gum troubles and with teeth.

In my college life I became a victim of gum troubles but my college physician advised to use the Paste which helped me and still now helping to possess a sound gum..."

(Sd/- Gour Kishor Chakrabarti, Burdwan)

Take care of your gums with Forhan's, the toothpaste created by a dentist

Dr. Forhan's exclusive formula

The powerful astringent action of Dr. Forhan's formula strengthens the gum surface to help you resist gum troubles.

Dentists say

Gum troubles can lead to the loss of even healthy teeth. So brush your teeth and massage your gums night and morning with Forhan's Toothpaste and Forhan's Double Action Toothbrush.



Gum troubles lead to health troubles



FREE! "Care of your Gums and Teeth." A colourful, informative booklet on dental care. Please write with 25 P stamps for postage, to:

Forhan's Dental Advisory Bureau, Post Bag No. 11463, Dept T 104-220 Bombay-400 020

Mention the language wanted.

Forhan's

the toothpaste created by a dentist

220 F-244

Regd T.M: Geoffrey Manners & Co. Ltd.

MELTRON COMPONENTS

...give your product
the competitive edge.



The range of quality Meltron Components includes:

- Semiconductor devices
- Magnetic and reed relays
- Carbon film and wire-wound resistors
- Thin film chip resistors
- Keyboard switches—reed and mechanical
- Modular push-button switches
- Multiturn potentiometer dials
- Toggle switches and single reed switches
- Illuminated switches

MELTRON
Meeting the challenge of tomorrow.

Write to us for more details.

Marketed by: Maharashtra Electronics Corporation Limited
Plot No. 214, Backbay Reclamation, Raheja Centre, 13th Floor, Nariman Point, Bombay 400021.
Tel. 240538 Telex. 011-6817 ME Cable: MELTRON
7A, Hansalaya, 15, Barakhamba Road, New Delhi 110001. Tel: 40641 Telex: 031-2815 MELN
55, Rama Nivas, 10th Cross, West of Chord Road, II Stage, Bangalore 560010. Tel: 80772.

CHAITRA-ME-113

LED power level indicator for stereos

A STEREO system consists of a stereo signal source and two separate (left and right) amplifying channels with loudspeakers. For good stereo effect, the relative loudness of the sounds from both the channels should be equal. This is called balancing the stereo system.

However, the human ear is not sensitive enough to detect small differences in the volume of sound, and, therefore, the conventional volume unit meters on stereophonic equipment are not of much help, as they average out the indication.

LED power level indicators are an extremely useful method of indicating instantly and accurately the output power levels and peak reading of both the channels of a stereo amplifier. They thus make the balancing much easier.

In a stereo system, with uniform setting of all the controls of both the amplifying channels, the acoustic outputs provided by the loudspeakers may not be exactly equal, because of (1) a difference in outputs from the two halves of the stereo pick-up head; (2) a difference in amplification between the two amplifying channels; (3) a difference in reproduction efficiency and directive properties of the two loudspeaker systems; (4) loudspeaker locations; (5) room acoustics and (6) the relative position of the listener. Thus, to achieve equal volume from a stereo system, the amplifiers are provided with either a separate volume control for each channel or dual gang, i e common volume control with a balance control.

The balance control knob is normally kept in its midway position. When this balance control knob is turned in one direction, it will increase the loudness of one channel while simultaneously decreasing that of the other, and *vice versa*. Though the stereo balance can be achieved with either of the volume controls or the balance control, it becomes a tedious job, for the human ear is not sensitive enough to detect small differences in the loudness. With the LED power level indicator described below, the imbalance of the channels will be shown by the lighted series of LEDs of the respective channels. When the balance is achieved, an equal number of LEDs will light on both channels.

The stereo signals from the left and right channel loudspeaker terminals are rectified with two separate half-wave rectifiers. This provides DC voltage which is proportional to the instantaneous output of their respective amplifying channels. A part of this DC voltage is fed, through a 1K potentiometer to the LED driving the transistorised circuit. The 0.1 mfd capacitor across the 1K potentiometer is for averaging the higher audio frequency music signals. When the outputs provided by either of the two channels of the stereo system becomes unequal by at least 0.6 volt or more, the number of LEDs lighted on each of the channels will also become unequal. If both the outputs of the stereo system are near equal, an equal number of LEDs of each channel will light. The 1K pre-set potentiometer should be fixed inside the unit and adjusted while playing the stereo system under balanced condition, so that both the LED chains will light an equal and maximum number of LEDs. The chart given below shows the respective voltage provided by the 1K potentiometer tap to the LED-driving transistors and the sequence in which the LEDs will light.

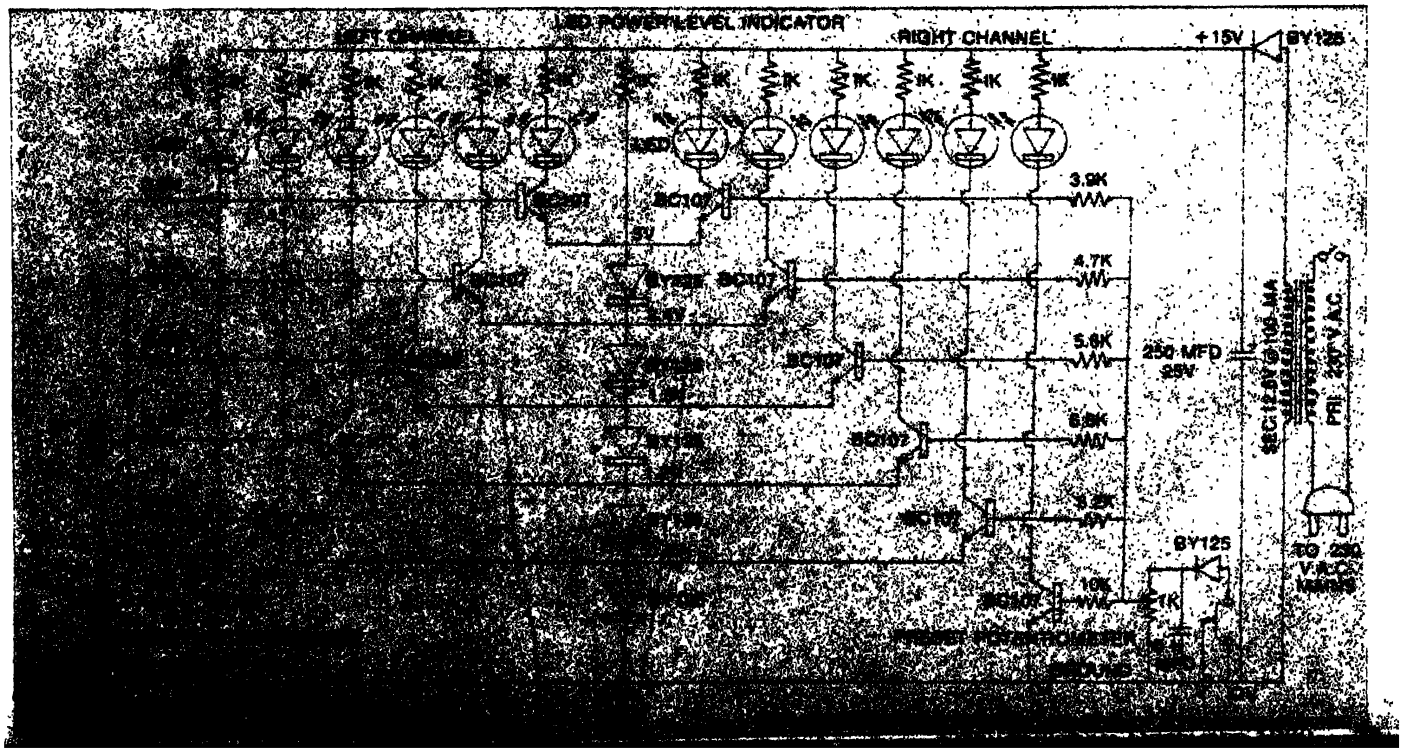
LED	Volts
1	1.3
2	1.3
3	2.0
4	2.7
5	3.4
6	4.0

This LED power level indicator can be used with any stereo system having low loudspeaker impedance, i e less than 15 ohms. Make sure that both the loudspeaker output terminals have a common ground which should be connected to the 'O' volt line of the device.

You will need:

Semiconductors: Transistors BC107 - 12 Nos.; LED Red - 12 Nos.; BY125 - 8 Nos.
Capacitors: 250 mfd - 25V (electroiytic) - 1 No.; 0.1 mfd (ceramic) - 2 Nos.
Pre-set potentiometer (carbon or wire-wound): - 2 Nos.
Resistors (all ½ watt): 10K - 2 Nos.; 8.2K - 2 Nos.; 6.8K - 2 Nos.; 5.6K - 2 Nos.; 4.7K 2 Nos.; 3.9K - 2 Nos.; 1K - 13 Nos.
Approximate cost of the above electronic components in Bombay market, Rs. 120.
Transformer: Primary 230V AC; Secondary 12.6V at 100 mA - 1 No.
Misc.: On/off switch, suitable enclosure, wires, solder, screws, vero board or printed circuit board, etc.

ANIL V. BORKAR





jaguar strikepower
INTERNATIONAL

Jaguar International is an aircraft specialised to meet India's defence problems.

It is supersonic.

It has outstanding payload/range performance.

It has short take-off and landing characteristics

It can operate from semi-prepared strips.

It has twin-engine reliability.

It has formidable air-combat capability.

It can accept long periods away from base maintenance facilities.

The two-seat version is a first-rate operational trainer which retains full strike capability.

With its combination of supersonic performance, exceptional payload/range capability and outstanding airfield performance, Jaguar has set new standards for economical strikepower when operating in support of ground forces in fast-changing battle environments. In service with the Royal Air Force, L'Armée de l'Air, and two other air forces, Jaguar has demonstrated its ability to:

- deliver formidable weapon-loads at very high speeds and over considerable ranges;
- penetrate sophisticated defences at high speeds and low level;
- make one-pass attacks in poor weather conditions with consistent accuracy;
- sustain high mission-rates even from forward bases providing only minimal technical support;
- defend itself against counter-attack in hostile air space.

Formidable capability.
Jaguar International has been developed to capitalise on the aircraft's ability to strike with a variety of underwing weapon-loads over a radius of more than 500 statute miles. Jaguar has two internally mounted 30 mm guns, with 150 rounds per gun, and overwing air-to-air missiles can be fitted to give a potent self-defence capability in hostile environments. The two-seat trainer version retains complete strike capability.

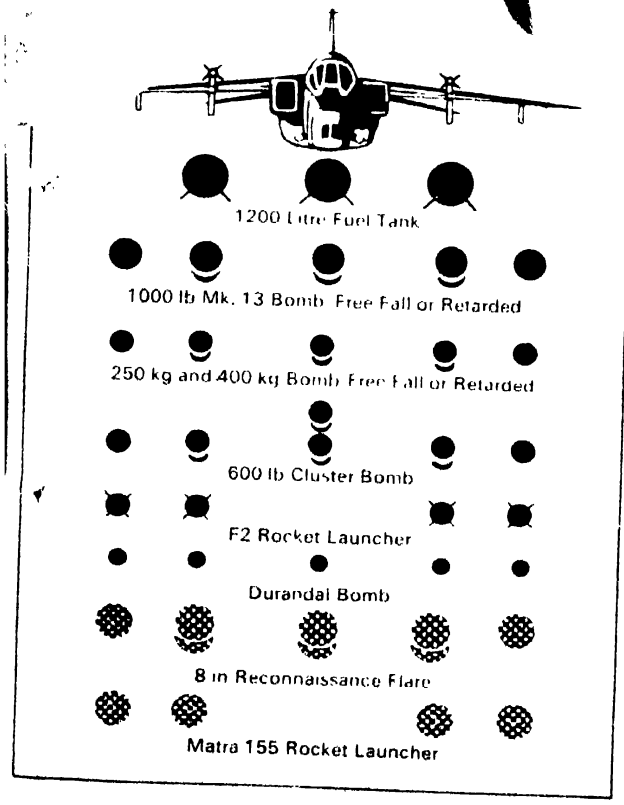
Short runways.
Jaguar can operate from short runways of low bearing-strength, with the optimum warload/range mix to suit a wide permutation of tactical requirements. Mission profiles can also be suited to specific targets and the strength and composition of the defences. At altitude, Jaguar International has a speed capability in excess of Mach 1.5 and it is designed for very high speeds at low level. Advanced aerodynamic design ensures low gust-response, enabling defences to be penetrated at transonic speeds and at altitudes of 80 metres and less.

Fuel tankage.
Internal fuel tankage provides a radius of action at full load of some 350 statute miles on lo-lo-lo tactical missions and over 500 statute miles on hi-lo-hi missions. External tankage can be used to increase these ranges, and Jaguar International is capable of a ferry range of well over 2,000 statute miles.

Forward airstrips.
With Jaguar operating from forward airstrips, tactical air commanders can mount interdiction and ground support operations over a wide area, extending beyond the immediate combat zone to targets some distance behind the battle line.

Nav/attack system.
Jaguar is compatible with nav/attack systems ranging from the simplest to the most sophisticated standards. The RAF system, for example, is among the most comprehensive yet applied to a close-support aircraft. At its heart is a navigation and weapon-aiming digital computer, with outputs to a head-up display and





projected map display. Feeding into the computer is an inertial platform, which makes the system self-contained and provides protection against interference and jamming. The RAF's Jaguars have a laser rangefinder and marked target seeker which gives a new order of accuracy to weapon delivery.

Survival ability.
Twin-engine configuration, duplicated systems and structural concepts which reduce vulnerability to battle damage give Jaguar excellent survival ability. It out-performs other tactical strike aircraft in terms of airfield performance (including ability to operate from unprepared strips), navigation/attack accuracy, and payload/range capability.

Development potential.
Moreover, because Jaguar was designed specifically to meet the defence needs of the 1970s and 1980s, it has a development potential which is only now beginning to be realised as increased engine thrust and additional weapons options become available. Already without superior today, Jaguar International is therefore capable of further development to match developments in the threat of attack.

Jaguar INTERNATIONAL

GIFT FROM JAWAHARLAL NEHRU PUBLIC LIBRARY

To be developed in India and built by **HINDUSTAN AERONAUTICS LIMITED, BRITISH AEROSPACE & DASSAULT/BREGUET, FRANCE.**

Clean fresh breath... Strong healthy teeth



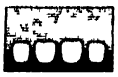
with Colgate Dental Cream

Brush your teeth with Colgate after every meal It protects you just the way dentists recommend all over the world

Bacteria grow in food particles left between your teeth These can cause bad odour and, later, painful decay

So always brush the Colgate way right after eating It's proven most effective to freshen your breath, whiten your teeth, and fight decay

How Colgate's trusted formula works



Odour and decay causing bacteria grow in food particles trapped between your teeth



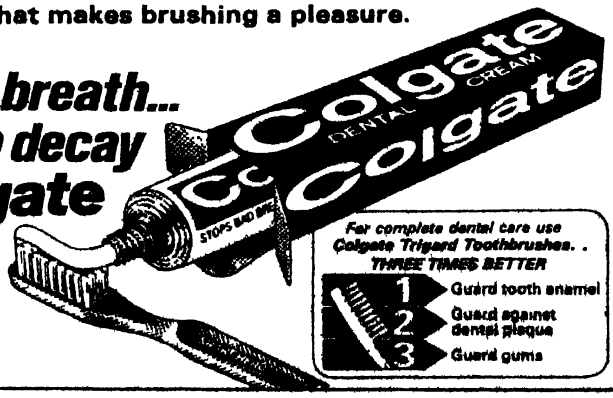
Colgate's unique active foam reaches deep to remove dangerous food particles and bacteria



The result attractive white teeth fresh-breath confidence, protection against decay

Colgate has the fresh, minty taste that makes brushing a pleasure.

Stop bad breath... Fight tooth decay with Colgate Dental Cream



DC G 73 80

How Asha got her fridge













On a deposit of Rs 100 a month for 48 months you get Rs. 5,727 00. Earn an interest of 6% to 10% p a. on periods of 12 to 120 months.

RECURRING DEPOSIT SCHEME

Central Bank of India

(A Government of India Undertaking)

The Bank that moves out to people and places

The breathtaking splendour of a clear night sky.... at 12 noon.



VEB Carl Zeiss JENA GDR

For over 2 years now, Bombay audiences have been thrilling to the panorama of the night sky at the Nehru Planetarium. A Carl Zeiss planetarium projector has made this possible. Elsewhere, Carl Zeiss instrumentation is opening new frontiers in several disciplines. From lenses to lasers. From microfilming to atomic spectroscopy. From the routine to the esoteric.

Available in India through our sole selling agents:

- Instruments for Astronomy, Planetaria, Microscopy, Medicine, Ophthalmology, Engineering, Metrology, Microfilming, Photogrammetry, Analysis & Survey.
- Measuring & Testing Equipment
- Lenses

CARL ZEISS JENA



Creative Unit 4592-R

NOGA

It's like having an orchard in your home!



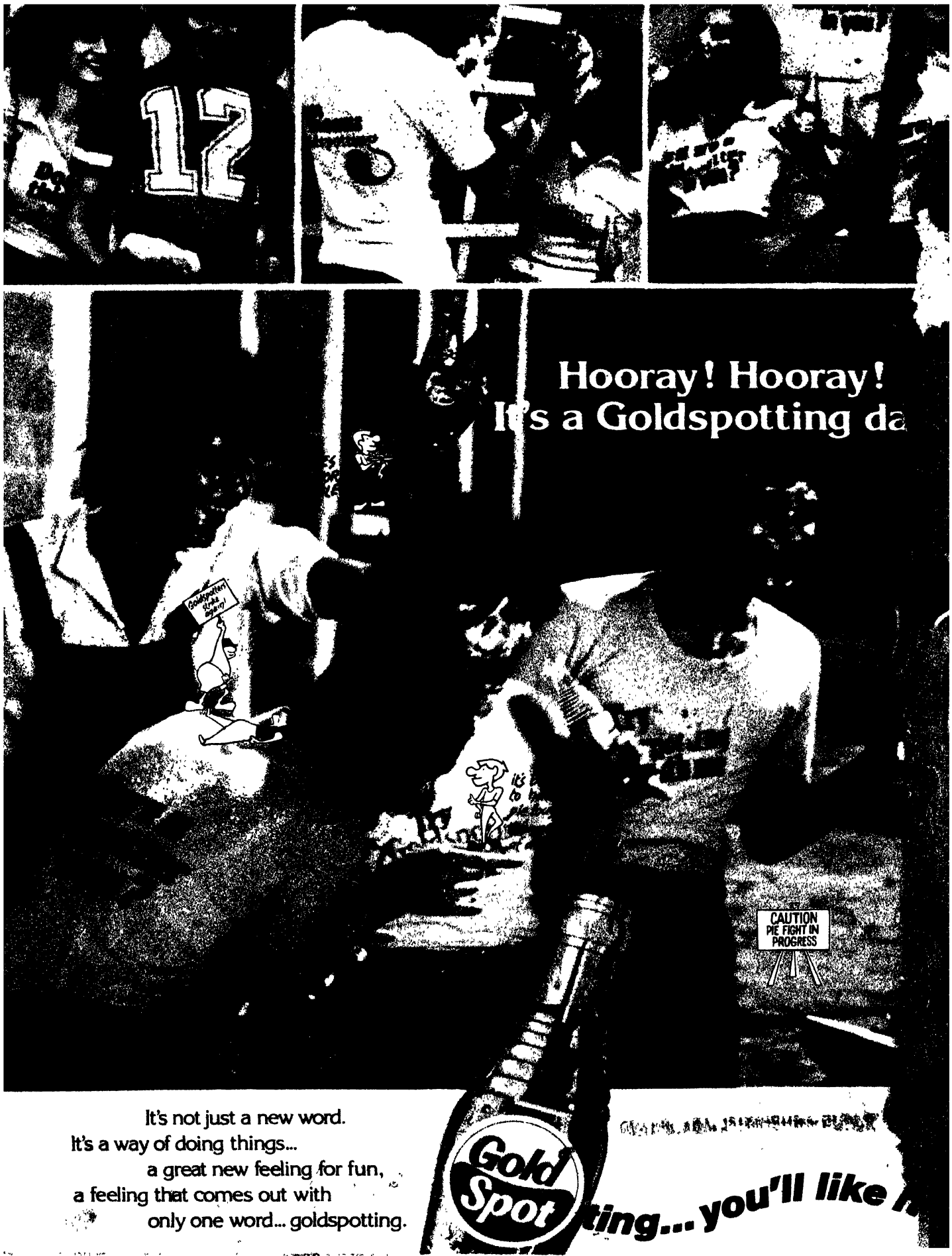
oh, oh, oh! it is good! just the thing



to get the most do yourself a flavour

Get
NOGA
IT'S ONLY NATURAL!
NOGA Squashes,
Cordials, Drinks,
Crushes,
Fruit Juices
and Syrups.




12
Hooray! Hooray!
It's a Goldspotting da
CAUTION
PIE FIGHT IN
PROGRESS
It's not just a new word.
It's a way of doing things...
a great new feeling for fun,
a feeling that comes out with
only one word... goldspotting.
Gold
Spot
ting... you'll like